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BULLETIN OF THE TORREY BOTANICAL CLUB
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MATERIALS FOR A DICTIONARY OF BOTANICAL TERMS—I

H. W. RICKETT

A language of precision is necessary in any science. The chemist has his symbols, the mathematician his formulae. The botanist, so far as he is neither mathematical nor chemical, relies upon a special vocabulary of his own to impart his concepts and descriptions to other botanists and to the layman; and this is particularly true of the taxonomist, whose task has been primarily to describe with precision the variable characters of plants to which numerical values cannot be assigned.

It is not surprising that the meanings of many terms have changed as botanical concepts have changed. We have a clearer idea than Linnaeus had of the homologies of floral parts, so that we no longer use such words as "calyx" and "perianth" in his sense. It is, however, somewhat disturbing to find that some terms have undergone a dichotomy in their meaning, so that comparable works by modern taxonomists sometimes contain different definitions of the same word. If the glossaries of these writers are a true guide to their usage, it is impossible to compare their descriptions without considerable translation. Physiology, morphology, cytology have similar growing-pains. In a recent lecture on the "growth-regulatory substances," the speaker devoted some time to a discussion of the names applied, properly or improperly, to these materials. Morphologists differ in their definitions of such common terms as "meristem" and "tissue." Cytologists argue over the meaning to be attached to one of the commonest words in their vocabulary, "diploid."

Botanical definitions may be traced back for several thousand years; but since modern botany has its roots chiefly in the eighteenth century, we may perhaps regard this period as a "starting-point" for modern terminology. Again this is particularly true of taxonomy, since our descriptions go hand in hand with nomenclature, which begins officially with Linnaeus in 1753. However, there is no rule of priority to guide us in selecting among conflicting definitions of terms; nor would such a rule be practicable. To return to the Linnaean concepts of 1751 would be only to compound confusion. Nor is it possible to insist on etymology as a sure guide to the meanings of words; scientific words acquire new meanings with time, just as do the words of common speech, and to disregard such meanings would be to render most modern work unintelligible. Several excellent botanical dictionaries have been published; each represents the attempt of one botanist to standardize the meanings of terms; none can be followed to the disregard of modern usage, and in fact none has been followed by all botanists.

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In short, the meaning of a term is a matter of *usage;* when usage is divided or confused, a meaning must be adopted by agreement. To write an authoritative dictionary of botanical terms is beyond the capacity of a single individual; decisions on the meanings of terms must be made by a group of botanists sufficiently representative that their colleagues may be "disposed to accept" the results. Nor is a mere compilation of all the definitions that have ever been propounded of any great use except as a necessary preliminary to decisions by such a group. We should not tolerate, in scientific language, a plurality of meanings for one term, as we do in ordinary speech. We should not have to rely on the context, nor does this always suffice to fix the meaning. To be uncertain whether "glabrous" means "free from hairs *and* roughness" or only "free from hairs" is as bad as if π should stand sometimes for the ratio of the circumference of a circle to its diameter and sometimes for something else; or as if Cu meant sometimes "copper" and sometimes "brass." Yet this is the state of affairs in botany today.

The following notes are offered only as examples of the spade-work that must be done, the raw materials that must be assembled, before a meaning can be adopted for a particular term. Starting with Linnaeus in 1751, some 25 definitions have been examined of each word. This is obviously not a complete summary of past usage. Such a summary would have been of historical interest only, and would merely clutter my pages without contributing further to the present purpose. A selection of writers has been made to demonstrate the usage of some of the more influential botanists of the past, from which our modern meanings have been derived; and to illustrate modern usage, with any divagations that may have crept in. Moreover I have limited my compilation to the English language; definitions in other tongues have been included only from certain classical authors who could not well be ignored. A similar compilation of modern usage in French, German, Russian, etc., must await the cooperation of botanists more familiar with those languages.

Historically it is interesting to notice, in passing, the different types of definitions given by past and present botanists: some, etymologically minded, attempt to preserve the classical usage; others content themselves with a laconic and often almost meaningless phrase; still others contribute details apparently of their own imagining in a praiseworthy but often ill-directed attempt at precision. It is true that one might trace the origins of terms through the pre-Linnaean darkness and back even to the more luminous times of Theophrastus or Pliny; but such meanings as the ancients gave to words, if they have influenced modern botany, have done so by being caught in the universal filter of Linnaeus' writings. The definitions of Augustin Pyramus de Candolle, however, of John Lindley and of Asa

Gray, of Nathaniel Lord Britton and of Merritt Lyndon Fernald must be taken into account for their influence on our own usage; also—a point not generally recognized—for an understanding of their own voluminous writings.

For convenience the authors whose works I have consulted are abbreviated in the text; the names, titles and dates corresponding to these abbreviations are listed below. Some readers will undoubtedly complain that I have omitted particular writers whose work they admire; if some are missing which should be included as being equally representative and equally influential, I shall hope to repair such omissions in future installments.

Synopsis of Works Cited in the Text, with Abbreviations

L: Linnaeus, Carl. Philosophia botanica. 1–362. *pl. 1–9.* 1751.

JBB: Bulliard, Jean Baptiste François. Dictionnaire élémentaire de botanique. i–viii, 1–242. *pl. 1–10.* 1783.

WW: Withering, William. A botanical arrangement of all the vegetables naturally growing in Great Britain. ed. 3. 1: i–xii, 1–402. *pl. 1, 2, 13–16, 19.* 1796.

DC: Candolle, Augustin Pyramus de. Théorie élémentaire de la botanique. i–viii, 1–500. 1813.

SFG: Gray, Samuel Frederick. A natural arrangement of British plants. . . . 1: i–xxviii, 1–824. *pl. 1–21.* 1821.

JL: Lindley, John. An introduction to botany. i–xvi, 1–557. *pl. 1–6.* 1832.

GWB: Bischoff, Gottlieb Wilhelm. Wörterbuch der beschreibenden Botanik. . . . 1–284. 1839.

JP: Paxton, Joseph. A pocket botanical dictionary. i–xii, 1–354. 1840.

AG: Gray, Asa. Manual of the botany of the northern United States. i–lxxii, 1–710. 1848.

———. First lessons in botany and vegetable physiology. . . . i–xii, 1–236. 1864.

JHB: Balfour, John Hutton. Outlines of botany. . . . i–xvi, 1–616. 1854.

GB: Bentham, George. Handbook of the British flora. . . . i–xvi, 1–655. 1858.

EB: Bastin, Edson Sewell. Elements of botany. . . . i–xv, 1–282. 1887.

AC: Crozier, Arthur Alger. A dictionary of botanical terms. i–v, 1–202. 1892.

R & F: Robinson, Benjamin Lincoln & Fernald, Merritt Lyndon. Gray's new manual of botany. (Seventh edition—illustrated.) 1–926. 1908.

B & B: Britton, Nathaniel Lord & Brown, Addison. An illustrated flora of the northern United States, Canada and the British possessions. . . . ed. 2. 1: i–xxix, 1–680. 1913.

BDJ: Jackson, Benjamin Daydon. A glossary of botanic terms with their derivation and accent. ed. 4. i–x, 1–481. 1928.

JCW: Willis, John Christopher. A dictionary of the flowering plants and ferns. ed. 6. i–xii, 1–752, i–lv. 1931.

AR: Rehder, Alfred. Manual of cultivated trees and shrubs hardy in North America. ed. 2. i–xxx, 1–996. 1940.

LHB: Bailey, Liberty Hyde. Manual of cultivated plants grown in the continental United States and Canada. ed. 2. 1–1116. 1949.

MLF: Fernald, Merritt Lyndon. Gray's manual of botany. Eighth (centennial) edition. i–lxiv, 1–1632. 1950.
CTW: Clapham, Arthur Ray, Tutin, Thomas Gaskell & Warburg, E. F. Flora of the British Isles. i–li, 1–1591. 1952.
HAG: Gleason, Henry Allan. The new Britton and Brown illustrated flora of the northeastern United States and adjacent Canada. 1: i–lxxv, 1–482. 1952.
and in addition:
CD: The century dictionary. An encyclopedic lexicon of the English language. ed. 2. 1899.
OED: The Oxford English dictionary. 1933.
WD: Webster's new international dictionary of the English language. ed. 2. 1942.

Glabrous. From the Latin *glaber,* "smooth, bald, without hair, wool, or feathers." So used by L ("quod superficie laevi est absque omni inaequalitate"), JL ("free from asperities or hairs or any sort of unevenness"; synonymous with *laevis*), WW, EB, AC ("smooth; free from roughness or hairs—the surface may be uneven"), R & F ("smooth; not rough, pubescent, or hairy"); also by OED ("free from hair, down, or the like; having a smooth skin or surface"), WD ("smooth; having a surface without hairs or projections"). Others have restricted it to surfaces devoid of pubescence or hairs but not necessarily smooth (free from roughness); so DC ("signifie qu'une surface quelquonque est absolument dépourvue de poils, ce qui peut arriver quoiqu'elle ne soit pas lisse"), GWB ("kahl, unbehaart, ohne Ueberzug von Haaren und Borsten. Wird von Vielen unrichtig durch 'glatt' übersetzt; vergl. *laevis*"), AG 1848 ("when the absence of hairiness alone is indicated"; contrasted with "smooth when destitute of hairiness and roughness"), LHB ("not hairy; often incorrectly used in the sense of smooth"). Perhaps the same was intended also by JBB ("ce qui est sans poils"), GB ("without hairs of any kind"), AR ("not hairy"), B & B ("devoid of hairs"), JCW ("hairless"), CTW ("without hairs"), though they are not explicit. Many writers are more or less evasive, using the word "smooth" together with such phrases as "lacking pubescence" (JP, JHB, BDJ, HAG, CD); since the meaning of "pubescence" also varies among these writers, their definitions necessitate especially careful comparison. "Smooth" is usually the opposite of "rough," and it is not always clear whether such definitions offer a restriction of the meaning of "smooth" to "lacking hairs but not necessarily free from roughness," or provide alternative meanings for "glabrous." AG in 1864 apparently did the former, varying from his definition of 1848 ("smooth, i.e. having no hairs, bristles, or other pubescence"), and providing material for complete confusion when his definition of "pubescent" of the same date is considered. MLF apparently has alternative meanings ("smooth, especially not pubescent nor hairy"; he treats "pubescent" in a similar way).

In my opinion the classical usage is to be preferred; but in any case modern usage must be clarified. In selecting among the various meanings, "glabrous" should be considered with "pubescent," since by some writers they are considered to be opposite.

Glabrate. From the past participle *glabratus* of a Latin verb *glabro* meaning "to make smooth"; it means therefore "made smooth" or "deprived of hair" and refers to surfaces formerly provided with hair (or other emergences, depending on the definition adopted for "glabrous"). It is not listed in most of the early works consulted (L, JBB, WW, SFG, JL, JP, JHB, GB). It was defined by DC in the correct etymological sense ("qui est devenue glabre"), and this was followed by GWB ("abgehaart, geschoren"). AG did not list it in 1848; in 1864 he defined it as "becoming glabrous with age, or almost glabrous," thus providing it with alternative meanings and helping it forward on its thenceforth equivocal career. He was followed by R & F, AR, LHB, and CD. AC ("nearly glabrous"), and B & B ("nearly without hairs") accepted only one of the alternatives, the one etymologically and historically incorrect. BDJ took a further step and made the word synonymous with "glabrous." HAG has "essentially without pubescence," which presumably means "glabrous or almost so." In WD it is synonymous with "glabrous" and "glabrescent" (which see). Some modern writers (CTW, JCW) do not list the word.

"Glabrate" has evolved from its original meaning, "made smooth," by the addition of a second meaning, "nearly smooth," and the gradual loss of the original meaning, to ultimate synonymy with "glabrous." If it merits retention as a term, it should have a meaning of its own, and this should preferably be the original meaning. In this sense "glabrate" is synonymous with "glabrous" as far as concerns the final condition of the surface described, but denotes that the surface had previously been other than glabrous. Since a botanical description must take account of seasonal variation such a term is of obvious value.

Glabrescent. Like "pubescent" (which see) from an "inceptive" Latin verb, *glabresco*, meaning "beginning to be glabrous," and hence, like "glabrate," to be used properly of surfaces not at first glabrous. It is a relatively modern introduction, though it is not in use by all modern writers. Those who include it define it almost unanimously as "becoming glabrous," (GWB, BDJ, AR, MLF, CTW, HAG, CD, WD, OED), which is an approximation of its original meaning; to some it is therefore synonymous with "glabrate." OED implies that the process of "glabration" is complete, which is etymologically incorrect. AR contributes an idea of his own: "becoming nearly glabrous with age." AC defines it as "slightly glabrous," and this absurd definition (equivalent to "characterized by the *slight absence* of hair, etc.") is given as an alternative meaning by BDJ and by WD!

It is clear that practical unanimity prevails on the meaning of this term among those who use it. It is clear also that both "glabrate" and "glabrescent" merit more careful definition if both are to be retained. Etymology may be of value in distinguishing them: "glabrescent" should be applied to surfaces from which the indument is beginning to fall or to become more sparse, while "glabrate" refers to a surface once not glabrous but now quite denuded.

Pubescence, Pubescent. From the Latin verb *pubesco*, which is an "inceptive" verb derived from *pubes* (manhood, or the hair which signalizes it) and meaning "beginning to be adult," or "beginning to be hairy." Since the beginnings of the beard are a fine down, the word pubescence early took the meaning of "fine short hair" or "down." L, however, used *pubescentia* to refer to any indument ("armatura plantae, qua ab externis injuriis defenditur"), though in applying the corresponding adjective to leaves he restricted it somewhat ("vide pilosa sed parum pilosa"; for his definition of *pilosus* see under "pilose"). Many of the older writers restricted "pubescent" to "downy" or the equivalent, and "pubescence" to the corresponding noun; so JBB, WW, DC, SFG, GWB, JHB, GB, EB. JL has different meanings for noun and adjective, defining "pubescence" as referring to a "short soft stratum, which only partially covers the cuticle," and "pubescent" as "covered with very short, weak, dense hairs." JP is alone in injecting the idea of "hoary" into the definition. To LHB, JCW, CTW also "pubescent" means "downy"; and this is the sense of OED and, less clearly, of WD. AG in 1848 followed L in using the noun ("hairiness in general") and adjective ("hairy with soft hairs") differently; but in 1864 he reversed these two meanings ("hairy or downy, especially with fine and soft hairs or *pubescence*"). AC and BDJ also follow L in using the noun for hairiness in general, the adjective for a restricted type of hairiness. Most recent writers—AC, R & F, AR, MLF—evade the issue, using such phrases as "covered with hair, especially if short, soft and down-like," thus in effect providing alternative meanings. CD also treats "pubescence" in this way, but of "pubescent" says "a general term, including villous, hirsute, strigose, lanate, etc., but when used alone in specific description denoting a soft or downy and short pubescence." The unrestricted Linnaean sense is adopted for "pubescent" by B & B ("with hairs"; they do not list the noun), and for both noun and adjective by HAG.

It is evident that the words have been used in two senses for 200 years. There is little justification, from a scientific point of view, for their retention in both, as is done in recent manuals; still less for assigning different meanings to noun and adjective. Of the two meanings, "down" and "downy" have the backing both of etymology and of most recent usage. It remains to characterize these words, to lend them some degree of pre-

cision; to say something of the relative length and softness of the hairs, and whether they are erect or appressed, straight or curved, etc.

Villose, Villous. From the Latin adjective *villosus,* "shaggy rough, hairy"; derived from *villus,* "long hair," etc.; it refers to hair that is coarse and bushy or unkempt. L however used it of a stem "pilis mollibus pubescens," and this characterization of "villose" as referring to *soft* hairs has stuck to it ever since (SFG, WD); CTW alone of the authors consulted retains the simple classical meaning of "shaggy"; GWB defined "villose" as "zottig, mit zottenhaaren bekleidet." Most botanists have, however, followed the classical usage to the extent of including "long" as well as "soft" or "weak" in their definitions; so JL ("covered with long weak hairs"), BDJ, AG ("shaggy with long and soft hairs"), EB, R & F ("bearing long and soft hairs"), JCW ("with long weak hairs"), and this is the sense also of OED. A number of more or less influential botanists in the past have differed in their concepts. To DC "villose" meant covered with "poils couchés nombreux, un peu mous," and to WW it meant "woolly" (cf. also JHB, "covered with long soft hairs and having a woolly appearance"); JL defined it as "when they [the hairs] are very long, very soft, erect, and straight"; while AR says it means "bearing long and soft, usually curved or curly, hairs." JP elaborates, as he is apt to, with "soft, close, long, loose hairs," and AC aimed at still greater precision with "covered with rather thin, soft, straightish, hairs, somewhat finer, softer and thicker than in Pilose." Some recent writers have added to the usual definition a statement that the hairs are not matted or interwoven or only obscurely so (B & B, LHB, MLF, HAG, CD, WD).

Modern usage, then, derived partly from the classical meaning and partly from Linnaeus, agrees on "clothed with long, soft hairs." Whether they are straight or curved, loose or dense or shaggy seems immaterial to the definition, though inserted irresponsibly by some botanists; soft hairs are likely to be of various forms. It is as well, however, to include the idea of their being not matted, if only because we have other words to take care of matted induments.

There seems little reason to maintain two forms of the word. Of the two, "villose" seems preferable to "villous" for the sake of uniformity with "pilose," "strigose," etc.; unless we are prepared to use instead of these words "pilous," "strigous," etc. (which are to be found here and there in the literature).

Pilose. From the Latin adjective *pilosus,* "hairy"; a *pilus* was a "hair." By L the term was limited to leaves "quum pili distincti elongati tegunt superficiem." This is close to the modern meaning of "villose," needing only the qualification "molles," and later authors added this (SFG, JP, EB, AC, B & B, CTW); so that there is some question whether both terms

should be retained. To DC, however, a *pilus* was "légèrement roide." JL on the other hand defined "pilose" as "covered with short, weak, thin, hairs," in opposition to both L and DC. SFG, GWB, GB, AC, JCW supposed that the hairs must be "distant" or "scattered." In recent times the length has been omitted from definitions, as by AG ("clothed with soft slender hairs"), R & F, MLF ("hairy, especially with soft hairs"), BDJ ("usually meaning having soft and distinct hairs"), JCW ("with soft scattered hairs"), LHB ("shaggy with soft hairs"), and the three English dictionaries consulted. HAG is alone in dropping the softness but retaining the sparsity of some earlier writers ("rather sparsely beset with straight spreading hairs").

The definitions of "pilose" by several of these authors can scarcely be distinguished from their definitions of "villose" (JP, EB, AC, B & B, HAG), and the distinction made by AR is one which no one else follows. In most of the pairs of definitions, that of "pilose" differs only in the lack of reference to the length of hairs; which of course could nevertheless be as long as those of a "villose" surface. To return to the classical meaning would be useless, since "hairy" would include "villose" and many other types of hairiness. The Linnaean definition also includes "villose" and is besides rather vague. A meaning must be selected from modern usage. If "pilose" is to be retained in use, botanists must agree whether it is to differ from "villose" in the sparsity of covering or in the length of hairs or both; and meanwhile the situation should be recognized in attempting to interpret descriptions of plants by ancient and recent botanists.

Hirsute. From the Latin adjective *hirsutus*, "rough, shaggy, bristly." L did not list the word in 1751. WW retained the classical meaning, as did SFG ("with rough pricking hair") and, with qualifications, GWB (the hairs "nicht stechenden") and JHB ("covered with long stiff hairs"). DC speaks of a "hirsuties" as "assemblage de poils longs et nombreux" without reference to roughness or shagginess. Subsequent writers varied in the amount of stiffness assigned to the hairs. JP straddled the fence with "rough, with soft hairs." AG vacillated, as he often did, between "hairy with long and slender and tolerably distinct hairs" (1848) and "hairy with stiffish or beard-like hairs" (1864). To GB "hirsute" meant "when the hairs are dense and not so stiff [as in hispid]"; AC, with his usual attempt at greater precision, said "clothed with rather numerous long coarse hairs, harsher than pubescent and less harsh than hispid." BDJ's definition is almost identical with that of AG in 1848, and JCW has the same idea. Most recent authors (R & F, B & B, AR, LHB, MLF) use the words "coarse" and "stiff," which are found also in the three dictionaries consulted. But CTW have "clothed with long, not very stiff, hairs," and HAG has "pubescent with spreading hairs."

In this vast confusion, one had best return to the classical meaning,

"rough, shaggy, bristly," and follow such recent definitions as those of R & F, B & B, AR, LHB, MLF; which have the advantage also of conforming with those of standard English dictionaries. See, however, under "hispid."

Hispid. From the Latin adjective *hispidus,* "rough, hairy, prickly, bristly, shaggy"—i.e. much the same as *hirsutus.* L used *hispidus* of surfaces beset with fragile stiff bristles ("[caulis] setis rigidis aspersus"; "quum setae rigidiusculae fragiles per discum folii sparsae sunt"). Much the same idea was expressed by DC ("hérissé de poils roides, un peu longs et fragiles"). However, throughout its history this word has meant, to most writers, simply "rough with bristles" (WW, SFG, JP, GB, EB, AC, R & F, B & B, BDJ, JCW, AR, LHB, MLF, CTW, HAG). This is the sense also of CD and WD. A few of the earlier writers, like DC, specified long bristles: JL ("covered with long rigid hairs"), GWB, JHB ("covered with long very harsh hairs"). On the other hand OED has "clothed with short stiff hairs or bristles; rough with minute spines."

There is obviously little difficulty with the general meaning of "hispid." The only question is whether it is sufficiently distinct from "hirsute" that both should be retained in use. It is difficult to measure "roughness" objectively, or to determine whether a surface is merely "rough" with strong hairs or "prickly" with bristles. On the other hand, when we deal with such things as plant leaves which intergrade in such characters, we can probably not escape the use of some terms of the "more or less" type; i.e. "more sharply bristly" for "hispid" than for "hirsute." This is the distinction made by recent writers. It is probably most clearly expressed by MLF, who defines "hirsute" as "pubescent with rather coarse or stiff hairs" and "hispid" as "provided with rigid or bristly hairs or with bristles."

Strigose. From the Latin *striga,* "swath or row of cut grass"; not from *strigosus,* which means "lean, meagre," though both words are connected with *stringo,* which among other things means to "bind together, pluck, cut off, compress." Hence the meaning of early botanists would seem to have been a "row of hairs or bristles." Later it came to mean a single "bristle." It is not surprising that the meaning of "strigose" also has varied greatly. To L it meant the same as "hispid." WW defined it as "furnished with strong spear-shaped bristles, or thorns." SFG added the qualification of a basal enlargement of each bristle ("with stiff, long hair, swelled at their root"); this idea was adopted by GWB and by JP (who as usual contributed several details of his own imagining: "covered with little upright, unequal stiff hairs, swelled at their bases"). DC had something quite different in mind for a *striga* ("petite écaille étroite, allongée et qui ressemble à un poil"); this concept of a hair-like scale, whose origin I do not know, has been generally disregarded by his successors, except that AC admits it as

an alternative ("covered with sharp-pointed rigid, appressed bristles or hair-like scales"), as does CD; and AG in 1864 changed "hair-like scales" into "scale-like bristles." The modern notion that the *strigae* are appressed goes back to the time of JL ("covered with sharp, appressed, rigid hairs") and is etymologically sound, since a "swath" lies on the ground; essentially the same definition is given by AG in 1848, GB, JHB, EB, R & F, B & B ("with appressed or ascending stiff hairs"), BDJ (who also gives "hispid" as a synonym), JCW, AR, MLF, WD; but OED has only "covered with strigae [stiff bristles] or stiff hairs." HAG takes "strigose" as describing "a type of pubescence in which the hairs are closely appressed to the surface and point in one direction," omitting any reference to sharpness or stiffness.

From its confused beginnings and dubious etymology, "strigose" has therefore acquired a meaning accepted by many recent writers of "beset with sharp, stiff, appressed hairs." Whether or not "appressed" implies "pointing in one direction," or whether this fact must be stated in the definition, remains to be considered; but certainly most appressed hairs are thus oriented.

Oval. From the modern Latin *ovalis,* which is synonymous with the classical *ovatus,* "egg-shaped." L, however, used both words: a leaf was "ovale s. ellipticum, cujus diameter longitudinalis superat transversalem, superiore & inferiore extremitate angustiore." Such a leaf differed from one that was "ovate" in being narrowed to both ends. This definition of "oval" as being substantially equivalent to "elliptical" (which see) was adopted by most botanists and is current today. So DC ("qui represente une ellipse régulière, c'est-à-dire. . . ."), JL ("elliptical, acute et each end"), GWB ("von Flächenformen, was die Gestalt einer ziemlich regelmässigen Ellipse hat. . . ."), JP, JHB, GB ("the ma[illegible]ical oval," whatever that is), LHB (who does not list "oval" but u[illegible]e word to explain "elliptic"—a reversal of the usual method). It came early to be understood that "oval" is a "broad" ellipse. GWB specified an ellipse "deren Längendurchmesser den der Breite nicht mehr als um das Doppelte übersteigt. . . ." AG in 1848 wrote "broader still [than oblong], but longer than broad . . . ," and in 1864 "broadly elliptical, or elliptical with the breadth considerably more than half the length." Much the same proportions were mentioned by AC and AR. Most recent writers, however, content themselves with "broadly elliptic" (EB, BDJ, MLF, HAG). JCW has "widish, tapering equally to base and tip," which as an exact description of a plane or solid figure is something less than satisfying. The dictionaries include both the etymological meaning, "egg-shaped," and the botanical usage, "elliptical."

Usage is here sufficiently uniform that we must adopt without serious question the definition of "oval" as "broadly elliptical"—without bothering to inquire whether eggs are ever elliptical in outline. Just how broad

"broadly" is is another matter; this is another of the "more or less" definitions like those of "hispid" and "hirsute" (which see). In evaluating such definitions as those of JL ("elliptical, acute at each end"), JHB ("elliptical, blunt at each end"), and AR ("broad-elliptic, about 1½ times as long as broad and round at the ends"), see first the discussion of "elliptic."

Ovate. From the Latin adjective *ovatus,* "in the form of an egg, oval." "Ovate," "oval," "ovoid" are all derived from *ovum,* "egg," the two last (which see) being modern Latin. *Ovatus* was applied by L to a leaf "cujus diameter longitudinalis superat transversalem, basi segmento circuli circumscripta, apice vere eodem angustiore." Hence "ovate" early acquired its reference to a plane figure rather than a solid (though JP had merely "egg-shaped," and several recent definitions—as R & F, JCW, MLF—seem to allow such an usage as an alternative). It was occasionally confused with "oval" and "oblong" and even with "elliptic," as by DC ("une surface plane en forme d'oeuf, c'est-à-dire, elliptique, mais dont le plus grand diamètre transversal n'est pas au milieu, mais au-dessous du milieu"), JL ("oblong or elliptical, broadest at the lower end, so as to resemble the longitudinal section of an egg"), and WD; this, however, is only a matter of wording, and the shape envisaged is the same as it was to L. Most botanists have defined it in accordance with the classical word, by reference to a hen's egg; so GWB, AG, JHB, EB, AC, R & F, BDJ, LHB ("with an outline like that of a hen's egg cut in two lengthwise, the broader end below the middle"; Dr. Bailey's egg was, I hope, hard-boiled), MLF ("having an outline like that of a hen's egg, with the broader end basal"). The last is satisfactorily worded; those who say "with the broader end downward" (AG 1864, R & F) or "below the middle" (GB, LHB) have forgotten that leaves may extend horizontally or even hang with the tip downward. Some writers specify that the word is to be used of plane surfaces only (DC, JL, GWB, AG, EB, AC, B & B, BDJ, LHB, HAG); others, as noted above, allow a wider usage, as do the three English dictionaries consulted. A few have attempted to specify a certain proportion of length to breadth; so GB ("when scarcely twice as long as broad, and rather broader below the middle, compared to the longitudinal section of an egg") and JCW ("about twice as long as broad, tapering to the tip"). These are undoubtedly attempts to differentiate "ovate" from "lanceolate"—a pair of terms which differ chiefly in degree; see under "hispid." HAG says only "descriptive of a flat organ widest below the middle and broader than lanceolate."

Of the general meaning of "ovate" there is little question; general usage conforms with the classical meaning. The only problem is whether to restrict this word to flat surfaces or to allow the wider usage of the dictionaries. See under "ovoid."

Ovoid(al). From the modern Latin *ovoideus,* "egg-like." This is derived

from the Latin *ovum*, "egg," and the suffix *-oides*, signifying "appearance, likeness"; since the latter was of Greek origin, GWB pointed out that the word should properly be *ooideus*, or, in Latin, *oviformis;* the suffix, however, was adopted into Latin and became a part of the language (one might as well question the propriety of adding the Germanic suffix "-ly" to words of Latin origin such as "apparent"). Forms both in *-oides* and in *-oideus* were apparently adjectival, but many English words in "-oid" are substantives (spheroid, alkaloid), and the suffix "-al" is added to make the corresponding adjectives. "Ovoid" was not listed by L in 1751; JBB gave the name apparently as a substantive "à une graine, à un fruit, &c. quand sa forme est à peu près comme celle d'un oeuf." DC has a like definition ("corps semblable à un oeuf, ou dont la coupe longitudinale est ovée"), also JL ("a solid with an ovate figure, or resembling an egg"), and R & F define it as "a solid with an oval outline," BDJ as "an oval or ovate body," and LHB as "a solid that is oval (less correctly ovate) in flat outline." Other writers have interpreted "ovoid" as an adjective, as SFG ("egglike," of fruits), GWB, JP, GB, EB, AC, B & B ("shaped like a hen's egg"), CTW, HAG. The dictionaries include both substantival and adjectival uses. AG wavers from noun to adjective, from a "solid oval" (1848) to "ovate or oval in a solid form" (1864).

With "ovate" and "oval" also available, the continued use of "ovoid" can only be justified by limiting it to solid forms and reserving "ovate" and "oval" for plane figures. In this sense it is almost universally used by modern botanists (although the suffix "-oid" does not necessarily connote solidity; see under "ellipsoid"). Whether it should be noun or adjective remains to be decided; presumably it should be both; or, if that is not allowed, it should be a noun (by analogy with asteroid, spheroid, alkaloid, ellipsoid, etc.), with "ovoidal" for the adjective.

Elliptic(al). From the Greek ἔλλειψις, "something left out," derived from ἐκ, "out," and λείπω, "to leave." It was used in classical times both for a figure of speech in which something is omitted, and for the mathematical figure (in reference to the angle formed by the conic section with the base). The mathematical ellipse may be defined in various ways; perhaps the simplest is as "a plane figure such that the sum of the distances from any point on its circumference to two fixed points is a constant." The definition is given here because there is no evidence that botanists generally have known exactly what an ellipse is and considerable evidence that some who have used the term would not know one if they saw it. To L, WW, DC, JL, AG, B & B, "elliptic" was synonymous with "oval" (which see) and meant nothing very precise or intelligible. Many botanists lost themselves in attempts to define what they meant without reference to mathematical terms; so JBB ("ce qui a une forme alongée, & dont les deux extrémités

sont arrondies & de même largeur''), GWB (''eine Flächenforme von zwei konvexen Kreisbögen eingeschlossen, die an ihren Vereinigungspunkten spitze Wenkel bilden, und ein krummliniges Zweieck darstellen, . . .''), AG (''oval or oblong, with the ends regularly rounded; with a flowing outline, the two ends alike in width''), BDJ, MLF, LHB. What is the ''width'' of a ''rounded end''? It depends upon where you measure it. A number of botanists have sought to restrict ''elliptic'' more or less exactly to a figure of certain proportions. ''narrower'' than ''oval''; so SFG (''once and a half or twice as long as broad, with rounded ends equal to each other''), GWB (''. . . höchstens doppelt so lang als breit. . . . ''), AC (''oblong, and rounded at the ends; longer than oval''), AR (''about two times as long as wide''), JCW (''narrowish, tapering equally to both ends''). CTW define ''elliptic'' by reference to a figure, which is not an ellipse. Several botanists, though using the term, have omitted it from their glossaries, doubtless on the wholly unfounded supposition that every one knows what an ellipse is, as they know what a circle is (JP, EB, R & F, HAG); in much the same class are those who define ''elliptical'' as ''having the form of an ellipse'' (JHB, B & B). A little diversion is furnished by AC, who defined ''oval'' as ''broadly elliptical'', ''elliptical'' as ''oblong, and rounded at the ends'', and ''oblong'' as ''longer than wide, with nearly parallel sides.'' AG in 1864 defined ''elliptical'' as ''oval or oblong'', ''oval'' as ''broadly elliptical'', and ''oblong'' as ''more or less elliptical.''

This sorry mess amounts to a chronicle of incompetence. If an ellipse is not an exactly defined mathematical figure, it is nothing of scientific value. It includes ''oval'' as currently understood, but not ''oblong.'' There seems no need for botched-up definitions of a figure ''with a flowing outline tapering to rounded ends of the same width'' or the like; or for attempts to restrict ellipses to ''narrow'' or ''longer'' figures. The layman intelligent enough to use a botanical manual is able to understand what an ellipse is; and there seems to be some question whether he might not be better informed on the subject than the botanist who is trying to instruct him.

Ellipsoid(al). From the Greek ἔλλειψις (see ''ellipse'') and ''-oid'' (see under ''ovoid''), meaning ''ellipse-like'' in one way or another. Mathematically the term refers to a surface all plane sections of which are ellipses or circles; and to the corresponding solid. There are several varieties; that to which reference is made by botanists is probably the ellipsoid of revolution. The word has been used also for a plane figure which is nearly elliptical. There seems to be a feeling among some botanists that the suffix ''-oid'' necessarily connotes a solid figure; there is no etymological basis for this, as is evident from such words as ''rhomboid'', ''cycloid'', ''tabloid''; it denotes only a resemblance of some kind. Botanically, however, ''ellipsoid'' seems to have referred from the beginning to an ellipsoid of revolution; it

was so used by DC and JL (though inaccurately defined as "solide dont la coupe longitudinale est elliptique"; "a solid with an elliptical figure"), by GWB (who supplies the only careful definition: "eine Körperform, welche um ihre Längenachse gedreht, überall im Umrisse als Ellipse erscheint"), B & B, BDJ (very inaccurately as "an elliptic solid"), MLF (carelessly as "solid but with an elliptical outline"; why "but"?), CTW ("of a solid object elliptic in longitudinal section"). Occasionally one finds it referring to a plane figure, "nearly elliptical" (AG 1864, AC). HAG has "shaped more or less like a football"—the variety of football not stated.

General usage is clear that "ellipsoid" is to be used for solid bodies rather than for the outlines of flat objects. If the meaning is "ellipsoid of revolution," as from the nature of plant parts it almost certainly is, then some such definition as GWB's should be formulated: "the solid generated by the revolution of an ellipse about one of its axes." "Elliptic in longitudinal section" is not enough; some ellipsoids of revolution are circular in some longitudinal sections. "With an elliptic outline" is true only if one views the figure from certain angles; from others it has a circular outline. As for the question whether it should be used as a substantive, an adjective, or both, see under "ovoid."

Oblong. From the Latin *oblongus*, "rather long." This vague sense is given also by OED; JBB defined it thus also ("ce qui est beaucoup plus long que large"). L used it of a leaf "cujus diameter longitudinalis aliquoties superat transversalem, & utraque extremitas segmento circuli angustior" (cf. his definitions of *ovalis* and *ovatus*); he seems to have had an ellipse in mind. To DC "oblong" referred to an ellipse having one axis much longer than the other ("une ellipse très-allongée"), and GWB concurred in this definition; also JL, JHB, and AG in 1864 (though his figure is not elliptical, conforming rather to the modern idea!). Many of the older writers used such vague terms that one cannot be sure of their concepts of "oblong"; so WW, SFG ("longer than broad, the ends being rounded"), AG in 1848 (who seems to have had in mind a shape between "ovate" and "lanceolate"), GB, EB (of leaves "that have a flowing outline and are two or three times longer than broad"). More recent botanists have specified a figure rounded at the ends and with parallel sides; and perhaps some of the vague definitions referred to above were really aimed at such a concept; so AC (but see under "elliptic"), R & F, B & B, BDJ, AR, LHB, MLF, CTW, HAG, CD. Some, like EB, still mention certain definite proportions, as AR ("about 3 times as long as wide"), MLF ("two to three times longer than broad").

The current concept of "oblong" is a useful one, for which no other term is in use; although its origin is obscure it should stand. There seems little

point to reviving the Candollean sense of an "elongated" or "narrow" ellipse, contrasting with "oval." Nor should we revert to the vagueness of the classical word; it may be of interest to recall that the word is used in special senses other than the botanical (by bookbinders, for instance). On the other hand, in view of the lack of agreement on the relation of length to breadth, it would probably be best to omit reference to exact proportions.

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After the above was written and sent to the editor, I discovered the article on the same subject by B. M. Schulze (Beiträge zur deskriptiven Terminologie. Bot. Jahrb. **76**: 109–133. 1953). Its chief value to the present discussion is that it represents an entirely different viewpoint. Taking as examples (curiously enough) some of the same terms as those which I have selected for treatment (elliptic, oval, ovate, oblong), Schulze proposes solutions based on etymological or "logical" grounds rather than on modern usage. Indeed the diagrams which he presents to illustrate the terms just mentioned (p. 119) are so far from American and English usage that if they were adopted most current descriptive writing in English (or in Latin by an English-speaking author) would be completely unintelligible. Which raises again the interesting question: To what extent are we able to understand current descriptions in German or by Germans?

Schulze also calls attention to one point which I should have treated and which must be treated in the future: the separate consideration of the general outline of an object and the form of its apex. According to Schulze, "ovate" can apply only to objects with a rounded end, like an egg; whereas in America we commonly use it of leaves which are egg-shaped in general outline but which may be rounded or acute at the apex.

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VEGETATION OF A PRAIRIE MARSH

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In the heart of Canada, where today there are the prairies and plains of southern Manitoba, during the Pleistocene Period glaciers covered all the country north and immediately south of the North American watershed and destroyed all its previous plant and animal life. As the Wisconsin ice-sheet melted, passing to the north, free drainage could take place only as long as the descent of the land sloped southwards. When the glaciers had receded beyond the watershed, the retreating ice blocked the natural outlet northward, the watershed halted drainage to the south, and a glacial lake was created. This lake filled the basin to the height of the lowest point over which an outlet could be found into the present Minnesota and Mississippi River valleys (Upham 1890, 1895; Johnston 1946). As the ice gradually retreated this lake extended northwards and finally became considerably larger than all the present North American Great Lakes together. Since 1879 this great glacial lake has been named Lake Agassiz by geologists, in memory of the great Professor Louis Agassiz, pioneer of our present understanding of the glacial periods.

Eventually, the glacial Lake Agassiz covered the major part of the province of Manitoba, some part of Saskatchewan, the southwestern corner of Ontario, the northwestern parts of Minnesota, as well as the wide Red River valley at the eastern border of North Dakota to just south of the boundary to South Dakota.

It is assumed that after the opening of the natural outlet northwards of the Lake Agassiz basin, perhaps 4–5000 years ago, the water was slowly drained from all the area except for the depressions which hold Lake Winnipeg, Lake Manitoba, Lake Winnipegosis and nearby lakes. This drainage seems still to be going on at a slow rate, as old people of the Interlake region remember considerable changes in the topography of the lakes since their first arrival two or three generations ago.

As long as the ice was south of the watershed, the vegetation followed its retreat northward. As soon as it began to retire north of the heights, however, the glacial lake prevented the vegetation from following the ice any farther. Exactly as in modern glacial lakes in the arctic and subarctic regions, there were but few lower plants which were able to invade the cold lake; but as the body of water grew bigger, its temperature must have increased enough for a richer vegetation to grow at its shores and to cover its beaches with marshes and forests. During the last stages of the retreat of the ice, when the glacial Lake Agassiz extended over its maximum area, its

southern beaches were, very likely, covered with temperate plants of the same kinds as are known at present from around the lakes and rivers of northern Minnesota, North Dakota, and southern Manitoba.

Nothing is definitely known about how fast the glacial lake retreated, but it is assumed to have disappeared comparatively quickly from some areas and more slowly from other regions. When considerable ranges were laid bare suddenly, the vegetation probably took over the land in a fairly short time and covered it with shrubs, trees and prairie plants, but in the case of a slow retreat, the first vegetation following the beaches might have been the shrub forests of the sand dunes, and, where the ground water level remained high, the plants of the marshes. Later on, when the area became drier, the prairie plants and shrubs took over the marshlands, together with oak and aspen in the scattered bluffs and groves.

Still it is possible to see differences in the floristic composition of the vegetation of regions in Manitoba covered by plants which have invaded the region either from east, west, southeast or southwest. In the eastern parts of the province there are typical Ontario plants from the Canadian biotic province, or species from the eastern and northern parts of the Hudsonian province (Dice 1943). In the western parts some Hudsonian elements are also met with, although the majority of the western plants of Manitoba belong to the Saskatchewan biotic province, including many of the typical prairie species. In the southern and central parts of Manitoba, however, most of the species of higher plants seem to belong to the Illinoian biotic province, sometimes mixed with Canadian, Saskatchewan, and a very few truly Hudsonian taxa.

At present the retreat of what is left of the old Lake Agassiz in the big Manitoban lakes seems to have slowed down to an almost imperceptible rate. There is, however, still an opportunity to study the advance of vegetation of its southern shore line as it might have been, by an analysis of todays growth, along the southern parts of Lake Manitoba and Lake Winnipeg. During the past century, man's extensive agriculture has, of course, affected the vegetation of the prairies a great deal, but as the prairie marshes are known to be extremely uncertain farmlands, most of their plant cover still remains intact, except for the effect of introduced weeds. Studies on the differentiation of the vegetation of the prairie marshes are, therefore, assumed to be able to throw light upon the complex interplay of factors involved in the development of the vegetation of our prairies as it occurred on and near the beaches of the retreating Lake Agassiz thousands of years ago.

During the past few summers the present authors have had good opportunity to study the vegetation of the prairie marsh at Delta at the southern shore of Lake Manitoba. The present paper is the first report on the results

obtained, to be followed by a more detailed publication on the flora, in which the nomenclature used here will be more fully discussed. The investigation was originally suggested by Dr. A. H. S. Gillson, President of the University of Manitoba, as well as by Mr. H. A. Hochbaum, Director of the Delta Waterfowl Research Station. It was financially supported by the University of Manitoba and the Winnipeg Trustees of the Delta Waterfowl Research Station. The writers wish to tender their sincere appreciation to all these individuals and associations for their valuable suggestions, help and advice, as well as to the personnel and visiting scientists at Delta for their continued encouragement.

Geographical survey. Lake Manitoba is about 180 kilometers long from north to south, and less than 52 kilometers wide east-west at its southern end, which is considerably broader than its northern parts. The lake is shallow, its depth nowhere exceeding 8 meters, although its water is so saturated with organic matter and fine silt as to make it practically impossible for the bottom to be seen at even one meter's depth. At its southern shoreline the wind and winter ice have built up a series of low and narrow sand ridges, the innermost of which, formerly a sand dune, is now covered by a thick wood of several species of trees, shrubs and herbs. In front of these woods, just at the shore, are invading communities of grasses, shrubs and even trees growing out into the water, while behind the woods is the real Delta marsh, extending about 30 kilometers east and west, and about 8 kilometers southwards, embracing almost 15,000 hectares of small lagoons and marsh vegetation (Hochbaum 1944). South of this marsh lie the prairies and rich farmlands of Manitoba with their small bluffs of oak and aspen.

The Delta marsh is about 250 meters above sea level and is formed on Devonian limestone, which here is covered by a thick layer of heavy lacustrine sediments (Ellis 1938, Johnston 1934, Moore 1949). The humus everywhere is thin. Sometimes only a few centimeters of top-soil cover the sand on the ridges, so that trees are too shallowly rooted for any reliable support against occasional strong gales from the lake.

In a cross-section of the Delta marsh (Hochbaum 1944) it is easily seen that inside the wooded ridge near the lakeshore, protected by shrubs and trees, there is a meadow with some pasture grasses, gradually changing into the *Phragmites* belt, which in turn is broken up here and there by more or less temporary sloughs with *Schoenoplectus, Typha* and some aquatic plants. These sloughs do not have any direct contact with the lake, but seem to depend entirely upon the precipitation and ground water level as do most of the small prairie potholes farther inland (Evans, Hawkins & Marshall 1952). They dry out in dry summers, but are ordinarily filled with water during the spring months. Inside the *Phragmites* belt, sometimes only a few meters from the ridge, at other times more than a kilometer from the forest,

are the lagoons or "the bays," shallow ponds of water which may cover areas of different sizes but are always connected by gaps or creeks to each other and to the lake itself. This connection affects the water levels in the marsh so that when the winds change the level of the lake it also increases or decreases the amount of water in the bays. In recent years, however, the strength of the wind tides has been modified by the dam across the outlet at Clandeboye Bay. The lagoons are never more than 2 meters deep, usually even less than one meter, and their bottom is covered by a thick layer of detritus. The shallower parts of the bays are filled with aquatic vegetation outlined by *Schoenoplectus* and *Phragmites*.

The *Phragmites* belt with its bays is the marsh proper. Southwards it successively changes into a wet grassland, and still farther inland this vegetation runs into different types of prairie and woods, most of which, however, have been cultivated and are at present covered with crops and farm weeds. In localities protected against man and his animals, the original vegetation can still be studied to some extent.

The marsh is constantly changing so that the prairie vegetation and the cultivated farmlands now take up areas which some decades ago were typical marshes. According to Hochbaum (1944 & unpubl.), the shrinkage cycle of the marsh was at its lowest point in 1944, while a new wet cycle began in 1945 and reached its peak in 1949 and 1950, and is now on the decline again.

A look at the land south of Lake Manitoba indicates that the retreat of the lake has occurred in waves of drought interspaced by more stable and more moist periods. A system of sand ridges on the prairie support this assumption. Every time a dry period or some other causes lowered the surface of the lake permanently, the tree and shrub vegetation invaded a sand ridge farther out, and the gap between the new and old shoreline became a new piece of marsh, while the old marsh, now with a lower ground water level, was filled with meadow vegetation. This new meadow gradually changed into the vegetation of drier localities, and after some time the endless prairie with its small forests took over the soils of what had been marsh in the past.

The ridge forest. The sand ridge separating the bays from the lake and protecting the life of the marsh from direct wave action and the coldest northerly winds, is covered by a thick forest of rather low trees, most of them below ten and few if any exceeding twenty meters in height even where the sand ridge is broadest. The sand off shore is moved around by currents and wave action, but in protected spots near the shore clay covers the bottom, and in this clay some of the larger green algae are usually found.

The ridge is never very high, but where it is low enough to be covered by lake water during northerly winds, there is found a real marsh vegeta-

tion, similar to that on the marsh side of the ridge, with protruding colonies of *Schoenoplectus* in deep water and *Phragmites* near the shore. A more detailed description of these associations will be given in connection with the marsh proper.

There is little doubt that most of the forests of the prairies of Manitoba may be classified as different associations of the boreal-circumpolar *Quercetea* formations (Braun-Blanquet 1951, Braun-Blanquet & Tüxen 1952, Klika 1948). This is, however, rather an inaccurate classification of the ridge forests of the prairie marshes. Here, the oak is fairly rare, and some parts of the forest, at least those closest to the lake, seem to have the main characteristics of the *Alnetea* forests of rich soils with high ground water level. However, the major part of the ridge forest might well be classified as some yet undefined variants of the *Quercetea*, or, to put it more precisely, as just one of the initial stages of the oak bluffs and aspen groves of the older and less moist parts of the prairies. As a matter of fact, the ridge forest cannot be classified as a single sociological unit, but is most correctly placed into different zone classes, with differences in soils, in ground water levels, as well as in composition of trees, shrubs and herbs.

The zone closest to the lake, flooded only occasionally in the spring and during storms, is a *Fraxino-Salicetum*, sometimes intermixed with the *Phragmition* of the shore but more often reaching out directly into the lake. The leading trees and shrubs closest to the shore are *Fraxinus pennsylvanica* Marsh, *Salix lucida* Mühl., *Salix amygdaloides* And., and *Salix interior* Rowlee, while the undervegetation is composed of the following species of grasses and herbs: *Agrostis palustris* Huds., *Phragmites communis* Trin., *Poa palustris* L.; Roth, *Calamagrostis canadensis* (Michx.) Bush, *Puccinellia airoides* (Nutt.) W. & C., *Elymus hirsutiglumis* Scribn., *Elytrigia repens* (L.) Nevski, *Schoenoplectus validus* (Vahl) Löve & Löve ssp. *creber* (Fern.) Löve & Löve, *Heleocharis palustris* (L.) R. & S., *Juncus balticus* Willd. var. *littoralis* Engelm., *Ranunculus Cymbalaria* Pursh, *Argentina Anserina* (L.) Rydb., *Comarum palustre* L., *Potentilla monspeliensis* L., *Spiraea alba* Du Roi, *Asclepias incarnata* L., *Plantago major* L., *Aster ericoides* L., *Erigeron philadelphicus* L., as well as a few individuals of *Juncus macer* S. F. Gray, *Juncus nodulosus* Wg., *Calamagrostis inexpansa* Gray, and *Sagittaria cuneata* Sheldon where the water may stay in depressions for a longer or shorter time. Not all the species listed are confined to this zone alone although they are more or less constantly met with here; and a few other species are also occasionally found in these associations.

Behind the shore zone there is a slightly different forest, growing on the lower parts of the ridge but never inundated by lake water. The dominating trees of this middle zone are aspen and maple, and bushes and

shrubs are more frequent than close to the lake. The undervegetation is rich both in grasses and herbs. Perhaps the association might be classified as a variant of the *Populo-Aceretum,* and it is characterized by at least the following species in different frequencies: *Populus balsamifera* L., *Populus Sargentii* Dode, *Populus tremuloides* Michx., *Fraxinus pennsylvanica* L., *Acer Negundo* L. ssp. *interius* (Britt.) Löve & Löve, *Salix nigra* Marsh, *Corylus americana* Walt., *Prunus virginiana* L., *Cornus stolonifera* Michx., *Sambucus pubens* Michx., *Grossularia oxycanthoides* (L.) Mill., and the undervegetation is composed of *Hierochloë odorata* (L.) Wg., *Zerna* cf. *purgans* (L.) Henr., *Roegneria pauciflora* (Schwein.) Hyl., *Trillium cernuum* L., *Maianthemum canadense* Desf. ssp. *interius* (Fern.) Löve & Löve, *Cerastium nutans* Raf., *stellaria longifolia* Mühl., *Moehringia lateriflora* (L.) Fenzl, *Thalictrum dasycarpum* Fisch. & Lall., *Thalictrum Turnerii* Boivin, *Agrimonia gryposepala* Wallr., *Geum triflorum* Pursh var. *ciliatum* (Pursh) Fassett, *Rubus* cf. *arundelanus* Blanchard, s.lat., *Rubus* cf. *flagellaris* L., s.lat., *Rubus pubescens* Raf., *Viola canadensis* L., *Viola rugulosa* Greene, *Chamaepericlymenum canadense* (L.) A. & Gr., *Pirola asarifolia* Michx., *Hackelia americana* (Gray) Fern., *Scutellaria epilobiifolia* A. Ham., *Calystegia sepium* (L.) R. Br., *Galium triflorum* Michx. There may be more species in some parts of this zone, especially as it is not possible to draw a sharp line between this part of the forest and the woods of the higher and drier parts of the ridge. Their boundary is often almost indefinable and fluctuating and some of the species of the undervegetation of the driest zone may occasionally invade the lower zones, and *vice versa.*

The forest of the driest part of the ridge and along its southern slopes is luxuriant, especially near the trail which runs through this zone in many places. In addition to the trees mentioned above, some elms and oaks are found here; and so this might well be regarded as the initial stage of the *Quercetea* of the real prairie farther south. The shrub and bush cover is very dense and woven through with vines and climbers making passage through the forest rather difficult in most places. In localities where the forest is most dense the forest floor is almost without vegetation, or with a mere scattering of a few individuals of *Aralia nudicaulis* L. and other shade loving plants; but along the trail as well as in openings and at the southern boundary of the forest, large numbers of sedges, grasses and herbs are to be found. The only orchid known from Delta, *Cypripedium pubescens* Willd., was collected in this zone, which otherwise is characterized mainly by the following species of trees and shrubs: *Populus Sargentii* Dode, *Acer Negundo* L. ssp. *interius* (Britt.) Löve & Löve, *Salix nigra* Michx., *Salix amygdaloides* Anders., *Salix lucida* Mühl., *Salix interior* Rowlee, *Ulmus americana* L., *Quercus macrocarpa* Michx., *Corylus americana* Walt., *Prunus virginiana* L., *Cornus stolonifera* Michx., *Rhamnus alnifolia* L'Hér.,

Sambucus pubens Michx., *Ribes americanum* Mill., *Rosa blanda* Ait., *Symphoricarpos occidentalis* Hook., *Rhus radicans* L., *Smilax lasioneura* Hook., and *Smilacina stellata* (L.) Desf. Some sedges are also rather characteristic of this zone, the most remarkable taxon being *Carex assiniboinensis* W. Boott. Grasses are also found, most of the tussocks composed almost exclusively of the prairie type of *Poa pratensis* L. s.lat., *Roegneria pauciflora* (Schwein.) Hyl., and some species of *Zerna*. Also, numerous species of herbs are met with in this region, most of them, however, not exclusively characteristic of this zone. The characteristic species seem to be *Polygonatum canaliculatum* (Mühl.) Pursh, *Urtica gracilis* Ait., *Oxybaphus nyctagineus* (Michx.) Sweet, *Humulus americanus* Nutt., *Ribes americanum* Mill., *Aralia nudicaulis* L., *Viola rugulosa* Greene, *Chamaenerion angustifolium* (L.) Scop., *Mentha canadensis* L., *Calystegia sepium* (L.) R. Br., *Echinocystis lobata* (Michx.) T.&G., *Sonchus uliginosus* MB., *Aster laevis* L., and *Aster simplex* Willd. Some of the species characteristic of the meadow and even of the marsh proper are sometimes found in this zone, and here and there some introduced weeds have found an appropriate spot within the typical communities of the inner forest of the ridge.

In a few places on the ridge there are sandy areas which are fairly open and are protected by only a few scattered trees. The vegetation of these areas changes gradually from the *Phragmition* at the shore to a real dune community, characterized by an association of the bluish *Elytrigia dasystachya* (Hook.) Löve & Löve, *Oenothera biennis* L. s.lat., *Arabis divaricarpa* A. Nels., a few individuals of the weed *Portulacca oleracea* L. and some other species. At such an opening of a dune in the central part of the ridge the first small trees of the forest belong to the hackberry, *Celtis pumila* Pursh, apparently its only point of distribution in western Canada. This small tree is found on sand dunes or rocky banks of streams or lakes from Quebec and the eastern United States to Minnesota and North Dakota (Fernald 1950, Jones 1950, Stevens 1950), and its nearest localities are in North Dakota not far from the southern limits of Lake Agassiz. It is very probable that the few individuals in the ridge forest at Delta are the last remains of larger colonies which have followed the retreating lake northwards but were unable to survive in the drier localities of the prairie. They are evidently north of their natural area, normally non-fruiting here, although a few seedlings not far from the mature individuals seem to indicate that seeds may be formed occasionally in hot summers.

The meadow. Only in a very few places does the forest change directly into the marsh proper. Usually, these two zones are separated by a more or less broad meadow, which sometimes might seem to be a treeless zone of the sandy ridge, and other times is perhaps a sandy and less moist part of the marsh intermingled with plant communities of the forest floor. However, it is equally correct to classify at least most parts of this zone as a

transition belt, greatly affected in some places by the activities of man, and therefore often characterized by a mixture of introduced weeds and native vegetation.

Grasses are the dominant plants of this zone, mainly those typical of sandy soils, but a few scattered trees and bushes are found. Close to the forest and under the trees and bushes the characteristic grasses are those of more shady areas, while the grasses of moist soils grow close to the marsh. Between these communities there are only the grasses of rather dry meadows, typically mixed with some introduced species. The following species of grasses have so far been collected in this zone: *Agrostis palustris* Huds., *Helictotrichon Hookerii* (Scribn.) Henr., *Poa pratensis* L. s.lat., *Alopecurus aequalis* Sobol., *Elymus canadensis* L., *Elymus hirsutiglumis* Scribn., *Elytrigia repens* (L.) Nevski, *Elytrigia Smithii* (Rydb.) Löve, *Muhlenbergia asperifolia* (Nees & Mey.) Parodi, *Panicum capillare* L., *Polypogon monspeliensis* (L.) Desf., *Setoria virides* (L.) PB., *Calamagrostis canadensis* (Michx.) PB., *Hordeum jubatum* L., *Zerna inermis* (Leyss.) Lindm., *Beckmannia syzigachne* (Steud.) Fern., *Spartina pectinata* Link, *Scolochloa festucacea* (Willd.) Link, as well as some rushes like *Juncus Dudleyi* Wieg., *Juncus Torreyi* Coville, and *Juncus balticus* Willd. var. *littoralis* Engelm. The patches of *Scolochloa* are mainly found close to the marsh proper, but the species does not grow to normal height in this zone and is never found to flower in the transition belt.

Close to the forest where the meadow is driest, the rich flora of herbs is composed of most of the same species as grow in the inner zones of the forest itself, but an admixture of weeds is evident. *Urtica gracilis* Ait. and *Sonchus uliginosus* MB. dominate large patches near the trees. Other characteristic species of these communities are *Comandra Richardsiana* Fern., *Oxybaphus nyctagineus* (Michx.) Sweet, *Anemone canadensis* L., *Actaea rubra* (Ait.) Willd., *Aquilegia canadensis* L., *Pentaphylloides fruticosa* (L.) Schwarz, *Rosa blanda* Ait., *Rosa arkansana* Porter, *Potentilla monspeliensis* L., *Oxalis stricta* L., *Zizia aurea* (L.) W. D. J. Koch, *Apocynum androsaemifolium* L., *Galium septentrionale* R. & S., *Galium triflorum*, Michx., *Campanula rotundifolia* L. s.lat. and a number of species represented by a few scattered individuals. Here *Axyris amaranthoides* L. also thrives, and *Heracleum lanatum* Michx., which is at present rare in Delta, seems to be confined to the marsh and to this part of the meadow, although it is probably present occasionally in other localities.

The part of the meadow closer to the marsh proper is characterized by more moisture loving plants like *Hippochaete laevigatum* (A. Br.) Farwell, which, however, is more typical for very dry spots on the prairies, *Equisetum pratense* Ehrh., *Equisetum arvense* L., *Rumex triangulivalvis* (Danser) Rech. fil., *Rumex crispus* L., *Tiniaria Convolvulus* (L.) Webb & Moq., *Persicaria coccinea* (Mühl.) Greene, *Persicaria Hartwrightii* (Gray)

Greene, *Plantago major* L., *Matricaria matricarioides* (Less.) Porter, *Solidago canadensis* L. var. *gilvocanescens* Rydb., *Solidago rigida* L., *Grindelia perennis* Nels., and a few other species.

All over the meadow, or perhaps most frequently not far from the road as well as in places directly affected by man, the flora is composed of *Polygonum aviculare* L. s.str., *Polygonum achoreum* Blake, *Chenopodium album* L., *Chenopodium gigantospermum* Aellen, *Amaranthus graecizans* L., *Amaranthus retroflexus* L., *Portulacca oleracea* L., *Alyssum calycinum* L., *Barbarea orthoceras* Ledeb., *Capsella Bursa-pastoris* (L.) Med., *Camelina microcarpa* Andrz., *Descurainia Richardsonii* (Sweet) O. E. Schultz, *Draba nemorosa* L., *Lepidium densiflorum* Schrad., *Thlaspi arvense* L., *Potentilla monspeliensis* L., *Medicago sativa* L., *Melilotus albus* Desv., *Melilotus officinalis* Lam.; Thuill., *Trifolium repens* L., *Euphorbia glyptosperma* Engelm., *Galeopsis bifida* Boenn., *Solanum triflorum* Nutt., *Ambrosia trifida* L., *Iva xanthifolia* Nutt., *Xanthium italicum* Moretti, *Achillea Millefolium* L., *Sonchus uliginosus* MB., some *Artemisia* species, as well as some yet undetermined and probably undescribed species of *Taraxacum*. In a few moist spots in the meadow zone, usually where they are shaded by other plants, there are also a few individuals of *Impatiens capensis* Meerb., *Chamaenerion angustifolium* (L.) Scop., *Oenothera biennis* L. s.lat. and other plants which may originally have belonged to the forest zone, or the marsh proper, or have been introduced by man or his animals rather recently.

It is difficult to define where the forest ends and the meadow begins, and equally troublesome to try to designate the end of the meadow and the beginning of the marsh proper. Although it might seem most natural to regard as the boundary of the marsh the point where the *Phragmition* forms its high and abrupt wall against the meadow, this is not quite appropriate from other points of view, as some of the invading communities of small plants of saline soils met with between the real meadow and the *Phragmites* belt are undoubtedly typical for the marsh itself. Most if not all these communities are also found in spots without tall grasses in the middle of the marsh itself. However, in places where the ground water level is very high and the meadow includes sedges as well as colonies of *Petasites sagittatus* (Pursh) Gray and ecologically similar plants the transition zone might seem to be absent or at least so narrow as to make it almost unobservable.

The marsh. Looking out from the observation tower of the Lodge of the Delta Waterfowl Research Station, a visitor gets the impression of the tremendous uniformity of the vast marsh. As far as the eye can see there is an almost level cover of *Phragmites*, broken only by the waters of the lagoons and sloughs and by patches of *Scolochloa*. Until at least the middle

of July the reeds appear as yellowish masses, but toward the end of this month and the beginning of the next the marsh turns green. A little later the *Phragmites* flowers, but due to the early appearance of frost in these regions, seeds are hardly ever produced before the marsh turns yellow again.

The *Phragmition* communities are always found in rather wet soils with a high ground water level. Usually they are inundated in the spring and in the summer whenever the water level of the bays rises. The drier parts of the marsh are characterized by the *Scolochloetum*, dominated by the tall grass *Scolochloa festucacea* (Willd.) Link, which seems to prefer soils inundated only in early spring, as it avoids the more moist places but rarely flowers unless the ground is very wet during its first period of elongation. Nevertheless, it is able to survive considerable drought, and in many places seems to reproduce by stolons rather than by seeds.

However uniform the marsh looks at a distance, a closer study reveals a great variety of associations of large numbers of species of plants. The soil of the marsh proper is somewhat alkaline, and the plant communities at its margin are almost exclusively composed of species of saline soil. The frontier associations of the marsh, including mainly the communities towards land but also many of the associations towards the bays, include species like *Triglochin maritimum* L., *Hordeum jubatum* L., *Puccinellia airoides* (Nutt.) Wats. & Coult., *Setaria viridis* (L.) PB, *Roegneria violacea* (Hornem.) Meld., *Heleocharis acicularis* (L.) R. & S., *Heleocharis palustris* (L.) R. & S., *Trichophorum caespitosum* (L.) Hartm. s.str., *Scirpus paludosus* Nels., *Schoenoplectus americanus* (Pers.) Volkart, *Juncus bufonius* L. var. *halophilus* Buch. & Fern., *Juncus nodosus* L., *Poa palustris* L.; Roth, *Cyperus Schweinitzii* Torr., *Polygonum ramosissimum* Michx., *Polygonum prolificum* (Small) Robins., *Atriplex hastata* L., *Chenopodium glaucum* L. ssp. *salinum* (Standley) Aellen, *Chenopodium rubrum* L., *Chenopodium album* L., *Salicornia rubra* Nels., *Suaeda depressa* (Pursh) S. Wats., *Spergularia marina* (L.) Griseb., *Argentina Anserina* (L.) Rydb., *Comarum palustre* L., *Cicuta maculata* L., *Sium suave* Watt., *Epilobium adenocaulon* Hausskn., *Calystegia sepium* (L.) R. Br., *Veronica scutellata* L., *Cirsium arvense* (L.) Scop., *Eupatorium maculatum* L., *Lactuca pulchella* (Pursh) DC., as well as colonies or individuals of *Urtica gracilis* Ait., *Persicaria coccinea* (Mühl.) Greene ssp. *pratincola* (Greene) Löve & Löve, *Persicaria Hartwrightii* (Gray) Greene, *Rumex fueginus* Phil., *Ranunculus Cymbalaria* Pursh f. *hebecaulis* Fern., *Mentha canadensis* L., *Stachys palustris* L. ssp. *pilosa* (Nutt.) Epling, *Teucrium occidentale* Gray, *Bidens vulgata* Greene, *Senecio congestus* (R. Br.) DC. ssp. *tonsus* (Fern.) Löve & Löve, and *Sonchus uliginosus* MB. There are also some individuals of *Schoenoplectus validus* (Vahl) Löve & Löve ssp. *creber* (Fern.) Löve & Löve,

Phragmites communis Trin., *Scolochloa festucacea* (Willd.) Link, and some other species of the marsh proper, which may or may not have invaded these drier spots by aid of runners.

An effort has been made to follow the succession of communities from saline spots in the marsh or at its frontier, to the real *Phragmition* communities of the marsh proper. Spots which seem to have been laid bare by frost action or by other climatic or human activities are first covered by a very typical *Salicornietum*, where the dominant species are *Salicornia rubra* Nels., *Suaeda depressa* (Pursh) S. Wats., and *Spergularia marina* (L.) Griseb., often followed by some individuals of *Glaux maritima* L. Although only the species *Spergularia marina* is the same in this association and in the *Salicornietum europaeae* as described by Wendelberger (1943), Klika (1948), Braun-Blanquet (1951), Braun-Blanquet & Tüxen (1952), and others, there is no doubt that these communities are quite vicarious and grow in fully comparable soils.

When this pioneer association has covered the bare soil for some time, it is invaded by members of the *Puccinellietum airoides*, and although this community is fundamentally different from the *Salicornietum*, the species of the latter are often found mingled with it even in its later stages. Perhaps, however, this is due not to a real mixture of representatives of two distinct associations but rather to the fact that a true *Salicornietum* in very small saline spots can be completely surrounded by the consecutive association. The *Puccinellietum airoides* of the Delta marsh is closely related to the *Puccinellietum maritimae* of Europe, as described by Christiansen (1927), as well as to some other *Puccinellions* (Klika 1948, Braun-Blanquet 1951, Braun-Blanquet & Tüxen 1952). Its species are, however, all different, as most of the plants characteristic of these associations in Europe are not found on the prairies of central North America.

The distinguishing species of the *Puccinellietum* of the prairie marshes is *Puccinellia airoides* (Nutt.) Wats. & Coult., together with *Chenopodium glaucum* L. ssp. *salinum* (Standley) Aellen, and, perhaps, *Aster praealtus* Poir. This association is here usually followed by *Polygonum prolificum* (Small) Robins. or *Polygonum ramosissimum* Michx., *Rumex fueginus* Phil., *Spergularia marina* (L.) Griseb. and some species of *Chenopodium*, and in some places it is also mingled with a few specimens of *Triglochin maritimum* L., *Juncus balticus* L. var. *littoralis* Engelm., *Juncus bufonius* L. var. *halophilus* Buch. & Fern. and some other plants of saline soils.

It has not yet been possible to follow the degeneration of the *Puccinellietum* of the Delta marsh in every detail. However, before it is invaded by the tall grasses of the marsh and their companions, herbs like *Senecio congestus* (R. Br.) DC. ssp. *tonsus* (Fern.) Löve & Löve and grasses like *Elytrigia repens* (L.) Nevski, *Roegneria violacea* (Hornem.) Meld., and *Setaria virides* (L.) PB. may have grown into it, before the beginning of

the reign of the real *Phragmition*, ruler of the marsh proper, is announced by the first individuals of *Heleocharis palustris* (L.) R. & S., *Heleocharis macrostachya* Britt., *Scirpus paludosus* Nels., *Schoenoplectus americanus* (Pers.) Volkart, some *Scolochloa festucacea* (Willd.) Link and *Calamagrostis inexpansa* Gray. On the other side, the *Puccinellietum* will be invaded by plants of the dry and less alkaline soils as well as by the weeds of soils affected by man, before the communities of the meadow take its place.

The associations of more alkaline soils usually change into the real marsh vegetation with a very narrow zone of intermixture. The height of the plants increases gradually, but as soon as the marsh, in the common meaning of the word, is reached, there is almost a wall of *Phragmites* and other grasses and sedges. *Phragmites communis* Trin., which in this part of the world is represented by the major geographical race ssp. *Berlandieri* (Fourn.) Löve & Löve with longer glumes than the typical European race ssp. *communis*, here covers almost endless areas and protects the animal and plant life with its tall, stiff straws even during the winter and until the new growth of the next year has reached its maximum height of 2–3 meters.

Phragmites is the predominating grass of the marsh in most of its phases. It grows where the soil is moistened only by spring floods as well as at the edge of sloughs and shallow pools. It is not found to grow far out into the lakes or bays, at least not in the Delta region, and it seems to avoid places where the water is more than half a meter deep during summer. Most of the humus of the marsh is formed by the disintegration of *Phragmites*, and all around the sloughs and bays its decaying straws form the rather sharp line of the shore. Its reproductive capacity is great, although almost exclusively vegetative, since the species flowers so late as to make the development of seeds almost impossible in normal summers.

As already mentioned the *Phragmition* marsh looks very uniform at first sight, but soon it becomes evident that it includes several zones with different associations. In most of these communities *Phragmites* is the dominant component, but here and there in the marsh, mainly where the water level is rather low and does not rise much above the ground except in spring, there are wide patches of *Scolochloa festucacea* (Willd.) Link, without any admixture of *Phragmites* but otherwise mingled with a few of the herbs and sedges of the real *Phragmition*. The *Scolochloa* patches, which sometimes may cover some hectares of marsh, are the main habitats of nesting ducks, especially in places where the grass is sterile. It is thought that this preference may be based on the fact that *Scolochloa* rarely flowers unless its bases are flooded for some time in the early summer, and ducks may know that the sterile patches are comparatively safe against water.

In the driest parts of the marsh the *Phragmitetum* includes a high num-

ber of grasses and sedges as well as most of the species of herbs of the frontier associations and some plants which seem to avoid other associations here. The most characteristic grasses and sedges in this zone are *Elytrigia repens* (L.) Nevski, *Calamagrostis inexpansa* Gray, *Glyceria grandis* S. Wats., *Carex atherodes* Spreng., *Heleocharis macrostachya* Britt., *Schoenoplectus americanus* (Pers.) Volkart, and *Scirpus atrovirens* Willd. Although most of the herbs previously listed from the marsh are found in this zone, the most conspicuous species seem to be *Urtica gracilis* Ait., *Persicaria coccinea* (Mühl.) Greene ssp. *pratincola* (Greene) Löve & Löve, *Persicaria Hartwrightii* (Gray) Greene, *Ranunculus sceleratus* L., *Lathyrus maritimus* (L.) Bigel., *Lathyrus palustris* L., *Epilobium adenocaulon* Hausskn., *Calystegia sepium* (L.) R. Br., *Mentha canadensis* L., *Stachys palustris* L. ssp. *pilosa* (Nutt.) Epling, *Teucrium occidentale* Gray, *Aster praealtus* Poir., *Aster ericoides* L., *Aster ptarmicoides* (Nees) T. & G., *Erigeron philadelphicus* L., *Bidens vulgata* Greene, *Cirsium arvense* (L.) Scop., and *Sonchus* Small trees of *Salix interior* Rowlee and *Salix amygdaloides* Anders. are sometimes found in the marsh, but although some of the species listed are relatively frequent the major part of the soil is without doubt covered by *Phragmites* alone. It is possible that this part of the *Phragmition* should be divided into several associations as it evidently is a mosaic of many smaller communities, but this is not an easy task as all the auxiliary species of these variations seem to be in a labile and uncertain connection with each other.

In the middle of the marsh there are much fewer species of herbs, and the dominating *Phragmites* may be found to be quite alone in large patches, perhaps accompanied by *Lemna minor* L. and *Lemna trisulca* L. in small depressions holding water, as well as by a few individuals of *Typha latifolia* L. and *Hippuris vulgaris* L. in the small potholes or pools.

Closer to the larger sloughs as well as in the neighborhood of the bays, the *Phragmition* changes again, and new species take over the dominant role when others disappear. The giant specimens of the soft stemmed bulrush *Schoenoplectus validus* (Vahl) Löve & Löve grow here together with the *Phragmites* instead of the grasses and sedges of less moist localities. In the shallow ponds there may be some clumps of *Typha latifolia* L., and in the water float *Lemna minor* L. and *Lemna trisulca* L. Other herbs of this association are *Alisma triviale* Pursh, *Sagittaria cuneata* Sheldon, *Sagittaria latifolia* Willd., and *Menyanthes trifoliata* L. ssp. *minus* (Raf.) Hultén, but only a few of the herbs of the drier zones seem to thrive in this part of the marsh which is in constant danger of floods. The frequency of *Schoenoplectus validus* (Vahl) Löve & Löve increases as the water approaches, and associated with it is the giant hard stem bulrush *Schoenoplectus acutus* (Mühl.) Löve & Löve. This community reaches all the way to the shore of the bays.

All around the lagoons the two species of *Schoenoplectus* just mentioned are found at the fringe as dominant plants. However, *S. validus* is not found near the outer part of the border, and is never found in deep water, perhaps due to the fact that it seems to need protection more than the other species. *S. acutus,* however, is found even in water about 150 cm deep, but although some colonies of it seem to grow as islands completely separated from the communities at the shore, the writers are inclined to believe that these islands are to be regarded as remnants only of a more continuous bulrush belt during a previous period of drought. Both these species seem to regenerate vegetatively rather than by seeds, and some observations made in Delta seem to indicate that the vegetative shoots grow out from the shore into deeper water, as is known to be the case with the closely related *Schoenoplectus lacustris* (L.) Palla of Eurasia (Seidel 1952).

Typha latifolia L. is not very common throughout the marsh, but it is found together with *Schoenoplectus acutus* (Mühl.) Löve & Löve in potholes in the marsh, as well as occasionally on somewhat deeper water in the bays. This species of *Typha* is found to vary considerably in this region, in leaf form, size of the plants, as well as in the form and size of the spike. All variations between the extreme broad-leaved form with the staminate and pistillate parts of the spike close to each other, to extremely narrow-leaved types with staminate and pistillate parts of the spike widely separated, are found. The latter extreme has been named f. *ambigua* (Sonder) Kronf., and it is a form, differing from the main type in a few inherited characters, although it is often mistaken for the species *T. angustifolia* L. (Evans, Hawkins, & Marshall 1952). These species are always easily distinguishable by aid of the pollen grains, which remain in tetrads in *T. latifolia* but not in *T. angustifolia* (Kronfeld 1889, Fernald 1950). The present writers are inclined to believe that this wide variation in combination of characters of *T. latifolia* in western Canada has nothing to do with introgression after hybridization with *T. angustifolia,* as this latter species is absent from this part of North America. Such an introgression has, however, undoubtedly been demonstrated from other parts of the continent where both the species grow together (Fassett & Calhoun 1952).

Although the lagoons, or bays, are often comparatively large lakes, they undoubtedly belong to the marsh proper and might even have been covered completely by marsh vegetation during short or long periods with a somewhat lower water level than now. They are also the sites of the innermost parts of the marshes of the future, when the water level has been permanently lowered, and the vegetation of the marsh is constantly diminishing them. Therefore, it is appropriate to treat them as if they were an integral part of the marsh proper.

Most of our studies on the vegetation of the bays of the prairie marshes

have been made on Cadham Bay and its neighborhood in Delta. There is, however, no doubt that the vegetation of the other bays is the same, or almost the same, so it may be assumed that the following account of the vegetation of Cadham Bay gives a fairly general picture of these shallow but large marsh lakes.

The vegetation of the bay-shore was described above, as well as the colonies of *Schoenoplectus acutus* (Mühl.) Löve & Löve, which sometimes form islands as much as 100 meters from the real shoreline. Between these islands and land as well as farther out in some parts of the lagoons there are large communities of different aquatic plants, most of them rooted in the bottom of the bay, some of them floating rootless close to the surface.

The pleuston, or megaplankton, of the bays and adjacent sloughs is of two kinds, using the classification of Daubenmire (1947), both of them kept in constant motion by wind and current. Of floating hydrophytes which absorb nutrients from the water but receive gases directly from the air, we find only the species *Lemna minor* L., while the suspended hydrophytes which absorb both air and nutrients from the water, are represented in the lagoons and at least some of the sloughs by *Lemna trisulca* L., *Utricularia vulgaris* L. spp. *macrorhiza* (LeConte) R. Clausen, *Ceratophyllum demersum* L. The latter species is very rare in this region. From a sociological point of view it is perhaps more plausible not to separate the two species of *Lemna* into two groups, since here they are frequently found growing together in rather large colonies. Sometimes, these colonies are found to associate with the *Utricularia,* but usually this species floats alone, perhaps accompanied by some green Algae and many small animals.

The anchored hydrophytes, which cover a good deal of the shallower parts of the bays and are rooted in the mud of their bottom, are also classified into different groups based on their gas and nutrient absorption. The submerged anchored hydrophytes which take up their air from the water and most of their nutrients from the soil, are composed of the elodeids of Du Rietz (1921, 1930), with the exception of the usually floating *Ceratophyllum* and *Utricularia* named above. In the bays at Delta this group is represented by associations with *Myriophyllum exalbescens* Fern. in large patches, *Myriophyllum verticillatum* L. in smaller colonies, as well as *Potamogeton pectinatus* L., *Potamogeton vaginatus* Turcz., and *Zannichellia palustris* L. The latter species seems to be much less frequent than the others and occurs only in rather shallow water near the shores. Although *Chara* was expected to grow in the bays, all efforts to discover colonies or single individuals of it have as yet been completely in vain.

The floating-leaved, anchored hydrophytes of Daubenmire (1947), or the group of nymphaeids of Du Rietz (1921, 1930), which in some lakes in eastern Manitoba are the dominant vegetation, are of only insignificant

value in the prairie marshes and their bays. *Nymphaea* is unknown from the real marsh region, and so is also *Nuphar,* but the group is represented in deeper water in the bays by *Potamogeton Richardsonii* (Benn.) Rydb. and in shallower water near the shore and in the sloughs by some small colonies of *Ranunculus sceleratus* L. f. *natans* Glück, and *Persicaria Hartwrightii* (Gray) Greene f. *fluitans* (Eat.) Löve & Löve.

The bays and sloughs as well as the vegetation of soils with a high ground water level take up the central parts of the marsh. South of them the marsh changes in the same way as to the north, and although the final alteration is a gradual one from the sociological point of view, there is only a narrow zone of alkaline communities between the *Phragmition* and the meadow vegetation as far as can be judged from the very few spots where this side of the marsh has not been spoiled by the activities of agriculture. In other places, and perhaps this was the usual change south of the prairie marshes before man came here, a belt of an association of *Scolochloa festucacea* (Willd.) Link and a few other species is found. This *Scolochloetum* is flooded in the early spring but later it remains dry. Like the real *Phragmitetum,* this association is very uniform and seems to be characterized by *Scolochloa festucacea* alone, perhaps mixed with a few specimens of *Carex atherodes* Spreng., and a few straws of *Phragmites communis* Trin. The *Scolochloa* flowers when growing near the real marsh, but farther inland, closer to the southern meadow, it never bears seed. Here it is also found growing together with different meadow plants and weeds, which become more and more frequent until the *Scolochloetum* changes gradually into some of the communities of the real prairie. Besides some of the more aggressive herbs of the marsh some agricultural weeds are at present found mixed with the *scolochloetum* at its southern border, so that species like *Hordeum jubatum* L., *Agrostis gigantea* Roth, *Urtica gracilis* Ait., *Polygonum ramosissimum* Michx., *Tiniaria Convolvulus* (L.) Webb. & Moq., *Chenopodium album* L., *Chenopodium gigantospermum* Aellen, *Ranunculus sceleratus* L., *Ranunculus Cymbalaria* L., *Descurainia Richardsonii* (Sweet) O. E. Schultz, *Thlaspi arvense* L., *Stachys palustris* L., *Bidens vulgata* Greene, *Cirsium arvense* (L.) Scop., *Artemisia biennis* Willd., *Lactuca pulchella* (Pursh) DC., *Aster ericoides* L., *Sonchus uliginosus* MB., and other noxious weeds may become predominant. When the farmer moves into such an area with too many animals, the wetter parts of the *Scolochloetum* may, in a short time, be transformed into a completely worthless stretch of unpalatable weeds and the moist parts of the alkaline soils are also found to respond negatively to other agricultural practices.

Although the prairies south of Lake Manitoba were virgin lands only a few generations ago, their present state of cultivation makes it difficult to decide if the meadows at the southern part of the marsh originally devel-

oped into a typical dry prairie, or changed into a forest of much the same type as the ridge forest of our times. The present writers are inclined to believe that both possibilities are true, so that in some places, mainly near the rivers, forests and bushes took over the former shores, while patches of prairie were typical for other parts of the land. This might seem to be supported by the fact that one of the earliest names of Portage la Prairie was Meadow Portage, as well as by the following sentences from the journals of La Verendrye, who saw these prairies in their pristine condition (Burpee 1927, p. 485): "Trees grow only on the banks of the rivers, and the prevailing kinds are white oak, elm, ash, some unknown trees, bass and birch. All the rest is prairie, with here and there clumps of wild plums."

Still, it is possible to study some patches of original prairie along an abandoned railway near Oakland as well as some bluffs with trees not far from there. The type of prairie met with here seems to belong to the tall-grass-composite prairie or a mosaic of this type of prairie and a *Poa*-composite prairie. A far from complete investigation near Oakland indicated that the dominant species of the prairie south of the marsh might have been *Andropogon scoparius* Michx., *Andropogon Gerardi* Vitman, *Muhlenbergia asperifolia* (Nees & Mey.) Parodi, *Panicum capillare* L., and *Poa pratensis* L. s.lat., as well as the following herbs and bushes: *Hippochaete laevigatum* (A. Br.) Farwell, *Zygadenus elegans* Pursh, *Polygonum ramosissimum* Michx., *Axyris amaranthoides* L., *Salsola Kali* L., *Kochia Scoparia* (L.) Schrad., *Anemone cylindrica* Gray, *Rosa arkansana* Porter, *Rosa blanda* Ait., *Spiraea alba* Du Roi, *Pentaphylloides fruticosa* (L.) Schwarz, *Psoralea argophylla* Pursh, *Petalostemum purpureum* (Vent.) Rydb., *Euphorbia glyptosperma* Engelm., *Eleagnus commutata* Bernh., *Apocynum androsaemifolium* L., *Asclepias speciosa* Torr., *Monarda fistulosa* L., *Orthocarpus luteus* Nutt., *Symphoricarpos occidentalis* Hook., *Ambrosia trifida* L., *Ambrosia coronopifolia* T. & G., *Iva xanthifolia* Nutt., *Achillea Millefolium* L., in the wide sense, *Artemisia frigida* Willd., *Artemisia gnaphalodes* Nutt., *Artemisia glauca* Pall., *Aster ericoides* L., *Aster laevis* L., *Aster simplex* Willd., *Heliopsis scabra* Dumal., *Cirsium Flodmani* (Rydb.) Arthur, *Erigeron philadelphicus* L., *Chrysopsis Ballardi* Rydb., *Grindelia perennis* Nels., *Helianthus Maximiliani* Schrad., *Helianthus subrhomboideus* Rydb., *Liatris ligulistylis* (Nels.) Schum., *Rudbeckia serotina* Nutt., *Antennaria microphylla* Rydb., *Solidago rigida* L., and *Solidago canadensis* L. var. *gilvocanescens* Rydb.

The forests south of the marshes have quickly lost the characteristics of rather moist locales; in a few places they have become aspen groves with *Populus tremuloides* Michx., but more often, the change has been to oak bluffs and oak forests with the typical *Quercus macrocarpa* Michx. mixed with some of the drought resistant deciduous trees still typical for this region.

The vegetation of the prairie marshes is the pioneer growth on the plains of central Canada as their soils are left virgin by the retreating lakes. The mosaic of smaller associations of plants of different ecological preferences within the marsh has conquered new areas and gradually left the older ones to another mosaic of associations of plants of the less moist meadows and prairies farther south. In appropriate localities, trees have taken their places to make the mosaic still more complicated and still more variable. It is an everchanging association in an everchanging world.

APPENDIX: NOMENCLATURAL INNOVATIONS

Phragmites communis Trin. ssp. **Berlandieri** (Fourn.) Löve & Löve, comb. nov., based on *Phragmites Berlandieri* Fournier (1877), p. 178.

Elytrigia dasystachya (Hook.) Löve & Löve, comb. nov., based on *Triticum repens* L. var. *dasystachyum* Hooker (1840), p. 254.

Schoenoplectus validus (Vahl) Löve & Löve, comb. nov., based on *Scirpus validus* Vahl (1806), p. 268.

Schoenoplectus validus (Vahl) Löve & Löve ssp. **creber** (Fern.) Löve & Löve, comb. nov., based on *Scirpus validus* Vahl var. *creber* Fernald (1943), p. 283.

Schoenoplectus acutus (Mühl.) Löve & Löve, comb. nov., based on *Scirpus acutus* Mühlenberg (1817), p. 33.

Maianthemum canadense Desf. ssp. **interius** (Fern.) Löve & Löve, comb. nov., based on *Maianthemum canadense* Desf. var. *interius* Fernald (1914), p. 211.

Persicaria coccinea (Mühl.) Greene ssp. **pratincola** (Greene) Löve & Löve, comb. nov., based on *Persicaria pratincola* Greene (1904), p. 36.

Persicaria Hartwrightii (Gray) Greene forma **fluitans** (Eat.) Löve & Löve, comb. nov., based on *Polygonum fluitans* Eaton ex Gray (1859), p. 400.

Acer Negundo L. ssp. **interius** (Britt.) Löve & Löve, comb. nov., based on *Acer interior* Britton ex Britton & Shafer (1908), p. 655.

Senecio congestus (R. Br.) DC. ssp. **tonsus** (Fern.) Löve & Löve, comb. nov., based on *Senecio congestus* (R. Br.) DC. var. *tonsus* Fernald (1945), p. 256.

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AN ANNOTATED KEY TO THE NITELLEAE OF NORTH AMERICA

G. O. ALLEN

These notes are based, apart from published papers, for the most part on an examination of a large number of specimens kindly lent to me in 1939 by the Herbarium of the New York Botanical Garden and on manuscript notes by the late James Groves.

The war naturally held up my studies. Since I started work on these plants Dr. R. D. Wood in 1948 has published his "Review of the genus *Nitella* (Characeae) of North America" which includes details of literature, illustrations and distribution. I am therefore confining myself to a key with comments in the case of *Nitella* and with a rather fuller account of the species of *Tolypella*.

My aim is to set out as simply as possible the distinguishing features of the forms that I consider should be treated as species; with problems of nomenclature and with varieties I am less concerned.

Dr. T. F. Allen's intensive study of this group for forty years, his building up a herbarium of 8000 sheets and 2000 slides (most of which unfortunately were not permanently enough mounted to survive) and the wide field that he covered, which included Japan, mark him out as one of the leading charologists. He was also responsible for a large number of new species. His many excellent papers were well illustrated though his descriptions are at times somewhat diffuse.

Following mainly some suggestions by James Groves, I have decided to set aside some of the new species as they did not appear to me to differ sufficiently from those already described. Allen, rightly in my opinion, laid great stress on the markings on the membrane of the ripe oospore, "Nordstedt markings" as he styled them, but at times he seems to have made too much of slight differences in them. One can for instance be reasonably sure about the markings of a particular species being granulate but nicer distinctions than coarsely or finely granulate it seems hardly safe to draw as the foundation of a separate species. Though there is every reason for thinking the membrane decoration is constant for a species one would naturally not expect to find every membrane of a plant identical.

Though I have disagreed with Allen on a number of points, mostly minor ones, my admiration for his splendid work on charophytes remains undiminished.

KEY TO NITELLA

HOMOEOCLEMAE

A. Anarthrodactylae

1. Gymnoecphalous

Dactyls obtuse (or abruptly pointed)
Dioecious
Membrane smooth ..... 1. *N. opaca*
Membrane granulate ..... 2. *N. obtusa*
Monoecious
Oospore c. 400 μ long: membrane boldly
Scars left by fallen gametangia ..... 3. *N. spanioclema* var. *nidifica*
No such scars
Membrane smooth ..... 4. *N. flexilis*
Membrane coarsely granular ..... 5. *N. californica*
Oospore small (275 μ long) ..... 6. *N. mexicana*
Dactyls acute
Dioecious ..... 7. *N. missouriensis*
Monoecious
Branchlets usually once furcate
Upper tier of coronula cells elongated ..... 8. *N. dilatata*
Upper tier of coronula cells not elongated
Oospore 240–300 μ long: membrane finely granulate ..... 9. *N. acuminata*
Oospore c. 400 μ long: membrane boldly granulate ..... 10. *N. Allenii*
Branchlets once to thrice furcate ..... 11. *N. Macounii*
2. Gloeocephalous
Stems very stout (c. 2 mm. diam.)
Dioecious ..... 12. *N. cernua*
Monoecious ..... 13. *N. praelonga*
Stems medium or slender
Oospore membrane tuberculate ..... 14. *N. capillaris*
Oospore membrane reticulate ..... 15. *N. Bastinii*

B. Arthrodactylae
Bicellulatae
Macrodactylae
Branchlets twice or more divided
Gymnocephalous
Medium size, up to 20 cm. high
Sterile branchlets more than once divided
Oospore membrane reticulate ..... 16. *N. mucronata*
Oospore membrane granulate ..... 17. *N. gracilis*
Sterile branchlets once divided ..... 18. *N. capitellata*
Very small, up to c. 10 cm. high
Oospore membrane reticulate
First fork sterile: oogonia solitary ..... 19. *N. tenuissima*
First fork only fertile: oogonia aggregate ..... 20. *N. pygmaea*
Oospore membrane granulate
Branchlets usually 8 ..... 21. *N. confervacea*
Branchlets usually 6 ..... 22. *N. Liebergii*
Gloeocephalous
Very small, up to c. 6 cm. high ..... 23. *N. minuta*
Medium size, c. 15 cm. high
Fertile branchlets not in small heads ..... 24. *N. intermedia*
Fertile branchlets in small heads ..... 25. *N. Asagrayana*
Branchlets once (occ. twice) divided
Sterile dactyls not minute: oospore membrane granulate

Oogonia aggregate ..... 26. *N. annularis*
Oogonia solitary ..... 27. *N. Morongii*
Sterile dactyls minute: oospore membrane reticulate ..... 28. *N. axillaris*
Brachydactylae
Oogonia solitary ..... 29. *N. oligospira*
Oogonia aggregate
Oospore small, c. 200 μ long ..... 30. *N. microcarpa*
Oospore large, c. 400 μ long ..... 31. *N. megacarpa*
Pluricellulatae ..... 32. *N. capillata*
HETEROCLEMAE
A. Anarthrodactylae ..... 33. *N. clavata*
B. Arthrodactylae ..... 34. *N. hyalina*

1. NITELLA OPACA Ag. A rather stout dioecious plant, c. 15–25 cm. in height, dark green to almost black when dried, sometimes incrusted. Allen's photograph in his Revised Synopsis (1892) is not very typical and, as he says, represents an elongated loose form; his lithograph also at the same place does not appear to illustrate the normal appearance of fruiting whorls; and in his Synopsis figure 42 he represents the dactyls as very much more acuminate than is usually the case. Allen gives 340–360 μ as the length of the oospore but I should say about 400 μ was more usual.

Readily distinguishable from *N. capillaris* by the absence of mucus, the larger antheridia and the difference in membrane markings.

Though the monoecious *N. flexilis* should be easily distinguishable from the monoecious *N. opaca* there are times, in the British Isles at any rate, when the distinction is not so easy as in the colder months *N. flexilis* may be found bearing only antheridia and later in the season perhaps only the ripe oospores. When mature the antheridium of *N. opaca* (650–775 μ) is decidedly larger than that of *N. flexilis* (500–625 μ) whilst the ripe oospore of *N. opaca* is considerably smaller than that of *N. flexilis*. In a sterile state they cannot be determined with certainty. Allen mentions that *N. opaca* fruits later than *N. flexilis*. Normally *N. opaca* is a smaller stouter plant and usually forms fruiting heads.

2. NITELLA OBTUSA Allen. A dioecious plant apparently c. 20–25 cm. tall. Only two gatherings—from the same locality—are recorded. The specimens I have seen do not show well the characters given by Allen. The specimen on which, according to a manuscript note on it by M. A. Howe, Allen based his description of the type is densely tufted but another of what purports to be the same gathering is not at all so. I am inclined therefore to think that the type specimen is a very young plant. The other specimen is valuable in bearing ripe fruit.

N. obtusa would appear to differ from *N. opaca* mainly by the absence of fertile heads, by the very small antheridium (c. 250 μ in diameter as against 650–775 μ in *N. opaca*), the granulate decoration of the membrane (as against smooth or scabrous) and the light chestnut-brown colour of the oospore (as against dark chestnut-brown to almost black).

3. NITELLA SPANIOCLEMA Gr. and B.-W. var. *nidifica* Daily. Typical *N. spanioclema* is a monoecious anarthrodactylous extremely fragile plant, having affinities with *N. flexilis* Ag. but with very few branchlets, usually 2–3, which are normally once (occ. twice) furcate; oospores rich red-brown and membrane decoration with wart-like protuberances on a mi-

nutely granulate base. It was hitherto only known from Ireland, where it was originally collected in 1916, and from one locality in Scotland in 1921.

Var. *nidifica* was collected in Alabama in 1947 by Francis X. Lueth and described by Mrs. Fay K. Daily in Butler University Botanical Studies vol. 9, p. 270 (1950) and differs mainly from the type in the much more numerous branchlets (3–10) and the secondary rays (dactyls) usually longer than the primary rays. The crowded upper whorls give it a Tolypella-like appearance which is quite different from the type. The oospore seems to be slightly smaller but of the same colour. There also occur, though not mentioned in the description of the type by Groves and Bullock-Webster but only in the caption to plate 9, figures 3–4, the conspicuous scars left by fallen antheridia and oogonia.

4. NITELLA FLEXILIS Ag. Monoecious. Very variable in size, from a few cm. in height to occasionally about a metre. The close resemblance to *N. opaca* and the points of difference have been noted under that species. Membrane pattern is of no help as it is somewhat similar with no pronounced decoration in either species.

Allen puts the size of the oospore as 425 μ long and 375 μ broad but I find the measurements usually 525 μ long and 450 μ broad, much the same as in British specimens.

var. *crassa* Br.

A form with stouter stems and shorter branchlets.

var. *nidifica Wallm.*

A form with the fertile whorls forming somewhat dense heads. I referred to this variety a plant collected by E. R. Buckell in British Columbia in July 1939.

These I consider the only two varieties that call for notice.

5. NITELLA CALIFORNICA Allen. Monoecious. Very similar to *N. flexilis* but separable at any rate by the oospore membrane being granulate. Allen gives one other difference viz. the size of the oospore (500–535 μ long) but as I have already mentioned oospores of about this length are found in *N. flexilis;* the oospore however of *N. californica* is more globuse. The size that Allen gives for the antheridium, viz. 285 μ diameter, might appear a further point of difference between the two but on a sheet from Lake County in the New York herbarium Allen has noted the antheridium size as 390–450 μ which is not very different from the size in *N. flexilis* and is indeed as large as the size given for this latter species by Allen.

The membrane being granulate and the oospore being rather globular seem to be the only points of difference from *N. flexilis. N. californica* is based on a plant collected in 1894; it is to be hoped further gatherings of it will be made. It differs from *N. mexicana* by the oospore being larger and the membrane granules being coarser.

var. *nidifica* Allen

A form with the fertile whorls in compact heads such as are found in *Tolypella.* Allen calls this "forma" *nidifica* but the exsiccata specimen from Humboldt Co. bears the label var. *nidifica* and on the analogy of *N. flexilis* it would appear to merit the rank of variety. Allen's plate 185 evidently represents this variety.

6. NITELLA MEXICANA Allen. A robust species closely allied to *N. flexilis* but with a much smaller oospore (275 μ long, as against 550 μ) and anther-

idium (245 μ as against 550 μ) and a very fine granulate decoration of the membrane. The primary ray too is considerably shorter than the secondary whereas the reverse is the case in *N. flexilis*. It is heavily lime-incrusted.

From *N. californica* it differs in the much smaller oospore which in that species is c. 500 μ long.

7. NITELLA MISSOURIENSIS Allen. (= *N. montana* Allen, *N. Blankinshipii* Allen and *N. occidentalis* Allen). I have decided to adopt the suggestion made in 1911 by H. and J. Groves in their paper on the charophytes of the West Indies (*Symbolae Antillanae* vol. 2, fasc. 1) to combine these four species. Allen distinguished them from *N. opaca* by the acuminate dactyl and mainly from one another by differences in the size of the oospore, the nature of the granulate membrane decoration and the size of the antheridium but these differences do not appear to be sufficiently pronounced to make recognition reasonably certain.

Allen at first took the gathering of his *N. montana* by Williams to be *N. opaca* but revised this opinion when he obtained the specimens from Crater Lake. He also described his *N. missouriensis* as having the size and appearance of *N. opaca* or still more to *N. capillaris*, to which he would have referred it had it not been clearly gymnocephalous, By subcapitata, the word he used, though no known species, Allen evidently meant *N. capillaris* by the reference to mucus and to April as the fruiting season.

The material available is somewhat meagre and mostly not of high quality. The two specimens I have seen of *N. montana* from two localities are rather small scraps. Similarly Allen's figure of *N. Blankinshipii*, a single gathering from Missouri, seems to represent the younger upper whorls only. *N. occidentalis* too is probably a larger plant than the height Allen gives of 8–10 cm.

The only well mounted specimen is Stuart Weller's gathering of *N. missouriensis* of 21 April 1890 from near Springfield, Missouri, which is figured in Allen's photogravure and magnified figure (both 1892) and is the type. This is supplemented by a poorer specimen of the same plant from the same locality by Kimmons in June 1895 which is valuable in bearing ripe oospores which were wanting in the original gathering.

I have therefore selected *N. missouriensis* as the name for this species. The main features are as follows. Dioecious, with stem moderately stout and internodes considerably longer than the branchlets. Sterile whorls of 6–8 branchlets, once forked, the primary rays about twice as long as the secondary. Secondary rays 2–4 (usually 3), one-celled, apex acuminate. Fertile whorls with much shorter branchlets and forming heads. Oospore c. 400 μ long and c. 375 μ broad, showing 5–6 sharp ridges, membrane granulate. Antheridium 650 μ or more in diameter.

A diffusely branched plant, c. 15–20 cm. tall, in size and appearance very like *N. opaca* but differing mainly in the dactyls being acuminate.

8. NITELLA DILATATA Allen. A diffusely branched monoecious plant, 15–25 cm. high. In the sterile whorls the branchlets are usually once furcate, occasionally simple. Allen's plate (1894) shows one instance of a twice-forked branchlet. The fertile whorls take the form of small dense axillary heads, the six branchlets being once furcate; terminal rays 2–5 (usually 3), inflated and tapering, rather like a candle flame, to an acuminate apex. The ultimate rays of the fertile branchlets resemble those of *N. clavata* but

the plant is distinguishable from *N. clavata* by being homoeoclemous, by its smooth oospore membrane and by the dense fertile heads.

Allen placed *N. dilatata* in his revised Synopsis on p. 9 (1894) under Heterophyllae but stating at the same time that the verticils were not truly heterophyllous. The branchlets of the sterile and fertile whorls are of course dissimilar (dimorphous) but there is no sign of branchlets in more than one circle; the species is not therefore heteroclemous and should not find a place next to *N. clavata.*

I should perhaps make it clear that this species is not gloeocephalous. Allen's Synopsis at p. 9 (1894) is apt to be misleading as the plant might appear to fall under his subsection Gloeocarpae but a reference to the Synopsis on pp. 1 and 2 (1892) will show that "aa Heterophyllae" is a major subheading.

In the only specimen that Allen mentions, viz. Canaan Forks New Brunswick, coll. John Moser, Sept. 1890, he gives the dimensions of the oospore as 440–480 μ long and 360–375 μ broad with 6–7 non-prominent angles but my measurements would give c. 425 μ long 375 μ broad and 5–6 striae, the colour a rich bright rusty-brown.

There is another specimen of this species collected by John Macoun (No. 8) from Ottawa River, 1895, along with some *N. Macounii.* On a New York herbarium sheet there is an envelope marked "is this *dilatata?*" in ink, presumably written by John Macoun, and "yes" in red pencil presumably in Allen's handwriting but my examination of the contents of the envelope disclosed that it was not *N. dilatata* but *N. Macounii;* in it however was a small portion of *N. dilatata* and as the locality on another specimen on the same sheet is Ottawa River, 1895, this is probably the date and locality of the envelope specimens. These are probably the specimens referred to in the two letters (in the *N. dilatata* herb. cover) from John Macoun to Dr. Allen dated 14 and 23 Jan. 1896.

The elongated upper tier of coronula cells is a very striking feature. I found them to be connivent and did not notice any quite as depicted in Allen's text figure (p. 19, 1894); nor should I say they were so elongated. This lengthening of the upper tier also occurs in the oriental species *N. furcata* Ag. On a fertile head I noticed a minute shoot at some of the nodes.

9. Nitella acuminata Br. (= *N. subspicata* Allen and *N. stellaris* Allen) var. *subglomerata* Br. A medium sized very variable substantially built monoecious plant, with once forked branchlets and acuminate one-celled dactyls. So far as I have seen all North American specimens have aggregate oogonia and so would fall under var. *subglomerata* Br. (*N. subglomerata* Br.).

This common species has a wide distribution reaching as far north as New York State but chiefly found in the South-Western States, it being really a tropical and subtropical plant.

Allen (1892) elected to reinstate Braun's *N. subglomerata* as a species as he considered that "*acuminatae*" must be used as the name of a group. I do not see why he need have made the change for this reason but he also thought it "clearly entitled" to specific rank. I prefer to follow Braun's latest views as expressed in the *Fragmente.* Incidentally Allen speaks of the membrane being "roughened or reticulated" and in his Key at the end of his paper on the monoecious acuminate group at p. 536 (Bull. Torrey Bot.

Club 23 (1896) he definitely puts the membrane as "reticulated." Were this so, one could not consider it as a variety of *N. acuminata* but in fact the membrane of var. *subglomerata* is not reticulate but granulate; this is also the view of Nordstedt and Groves.

A form styled brachyteles by Braun (*Fragmente* p. 37) with very short secondary rays is recorded from St. Louis, Missouri and from the delta of the Mobile River, Alabama, leg. C. Mohr. To this form I consider *N. stellaris* Allen and *N. subspicata* Allen both belong. Allen's two species are very alike. They were both described in 1896 from plants collected by J. W. Blankinship. Allen found the membranes of both to be smooth but I think they are finely granulate.

Zaneveld also at p. 574 in his paper on Malaysia (1940) considered that these two species most probably belong to var. *subglomerata* as the only difference he could find was in the oospore membrane being quite smooth but a difference in the decoration of the membrane he did not consider by itself sufficient to amount to a specific difference. On this point I do not agree with him; if I considered there was a marked difference in the membrane decoration I should not combine them.

Incidentally I find a remark by Groves on a specimen from Kuala Lumpur, Malay, coll. H. P. Hacker, No. 764, 17-11-1922, Herb. Kew, that the dactyls are all abbreviated, very acuminate and exactly like those of Allen's plate of *N. stellaris*.

N. Lindheimeri, perhaps a nomen nudum, Allen thought presented no "essential difference from the typical *subglomerata*."

N. Gollmeriana Br., recorded from the West Indies, also appears to fall under form brachyteles. Groves in his paper on Ceylon charophytes (Linn. Soc. Journ., 46, 98 (1922)) expressed the view that the comparative length of the primary rays and dactyls was of little value in this species.

10. NITELLA ALLENII nom. nov. (= *N. glomerulifera* (Braun) Allen). A slender lax monoecious plant, up to 30 cm. high, with internodes usually shorter than the branchlets of the sterile whorls; branchlets c. 6, simple or usually once furcate, with a tendency to curve inwards; primary rays about the same length as the secondary which may be 2–3 (usually 2) with the apex acuminate.

Fertile whorls in small dense heads c. 8–10 mm. in diameter or smaller, usually axillary in nature and far over-topped by the sterile branchlets; branchlets 8, secondary rays 3–5 (rarely 5). Oogonia solitary, coronula persistent. Oospores c. 400 μ long and c. 300 μ broad, bright reddish-brown with 7 non-prominent ridges, membrane boldly granular, the granules of different sizes. Antheridium c. 400 μ in diameter.

Braun considered this plant a subspecies of *N. acuminata* with which it agrees in having acuminate one-celled dactyls but its membrane markings are quite different from the usually fine granules of *N. acuminata*. Allen's plate (pl. 8 vide Wood) (1892) gives a particularly good idea both of the plant as a whole and of the membrane decoration. In a plant collected by W. C. Muenscher, No. 351, on 5 Sept. 1935 in Pleasure Lake, Sullivan Co. New York, I found the decoration exactly as Allen has depicted with the granules, if they can be so called. large and roundish. The oospore too in *N. glomerulifera* is considerably larger than in *N. acuminata* (240–300 μ long, 200–250 μ broad).

The label on Allen's specimen (Ch. Amer. Exsiccatae no. 32) from Green Pond, New Jersey in Sept. 1883 mentions its being common in Lake Ontario, Savanac Lakes and probably in other deep and pure waters. Muenscher's fine specimen, quite 30 cm. in length, was obtained by a dredge in a depth of 1–3 m.

On a plant received from J. S. Karling in Oct. 1926 from New Jersey, Groves has a manuscript note that he found a case of geminate oogonia and put the colour of the oospore as reddish-orange and the length at 370 μ with 8–9 well defined low ridges.

As Allen points out this would appear to be more a northern than a southern species, the reverse being the case with *N. acuminata* var. *subglomerata*. I entirely agree with Allen in giving specific rank to this plant.

Groves has noted in manuscript that if retained as a species this plant must be renamed. This view is confirmed by my enquiries at the British Museum (Nat. Hist.), the use of the name by Ruprecht and Kützing for another plant rendering it inadmissible. I have accordingly named it after Dr. Timothy Field Allen.

11. NITELLA MACOUNII Allen. A small (10 cm. high) monoecious markedly dimorphous (not heteroclemous) plant, densely tufted owing to the very short stem internodes in the younger parts of the plant. Sterile whorls of 8 branchlets, 1–3 times furcate, primary rays usually rather over half the total length of the branchlet, secondary rays usually 4 (occasionally 5) varying in length, sometimes all simple and 2-celled or two again divided into 2–4 (usually 3) tertiary rays of which one may again divide into 2–3 quaternary rays. Dactyls 1-celled, sometimes 2-celled (v.i.), apex tapering and terminating somewhat abruptly in a sharp point. Fertile whorls in small heads in the axils of the stem whorls, branchlets c. 6; gametangia at 2nd and 3rd forks.

In addition to J. M. Macoun's two gatherings from Niagara Falls in Aug. 1882 and from Lake St. Clair in Sept. 1885 mentioned by Allen (1894), there are a few other records (I have already referred under *N. dilatata* to the specimen collected by John Macoun, probably from Ottawa River in 1895) viz. Wilmot, S. Dakota, no. 4009 and Clear Lake, S. Dakota, no. 4010 both leg. Allen and Saunders in Aug. 1898 (Hb. Harvard Univ. ex hb. de Alton Saunders); French River Harbor, Parry Sound, Ontario, leg. C. O. Grassl, no. 2097, Sept. 1932 (Hb. Univ. Michigan); French River Mouth, Ontario, Walter Koelz, no. 4767, July 1932 (Hb. Univ. Michigan). The Niagara and St. Clair Lake specimens are considerably lime-incrusted.

There has been much difficulty (some material in fluid would probably have avoided this) in elucidating this plant. Allen originally described it in 1887 as a *Tolypella*, stating that it was a most remarkable one because of the terminal rays of the fertile branchlets being 1-celled, so little fruit and such imperfectly formed nests and adding that it was *Nitella*-like in its habit of growth. The following year however after he had received from Macoun some small specimens of the same plant from Lake St. Clair, he found the antheridia to be terminal and not lateral and the plant therefore a *Nitella*. In the little Key at the end of the article, Allen classing it as heterophyllous, gave the points of difference between it and *N. Stuartii*, amongst them mentioning that in *N. Macounii* the ultimate rays were often 2-celled. On this last point J. Groves has a manuscript note "the 2-celled

ultimate rays seem to be due to suppressed forkings, not to their being 2-celled dactyls."

As to heterophylly, Allen's original plate 52 rather suggests this though Allen distinctly spoke of the stem whorls consisting usually of four branches bearing fertile heads and 8 sterile branchlets. In his Synopsis of *Nitella* (p. 43, 1888) though placed next to *N. Stuartii*, Allen no longer put it under the "Heterophyllae." In my opinion it is undoubtedly homoeoclemous.

As to the oospore membrane decoration, Allen's original description in in 1887 gave it as smooth but I have not been able to find any ripe fruit on the Niagara specimen and this is supported by a request in Nordstedt's letter of Nov. 17, 1887 to examine the structure of the nucleus between the striae "if you get quite ripe fruits." In his 1894 description Allen remarked that the "surface is peculiarly marked by short elevations (see plate)." On a specimen (Herb. New York, without date) collected by Jas. M. Macoun in St. Clair River, Ontario, determined presumably by Allen, as "new near *Macounii*" there is a manuscript note "membrane of spore beautifully marked (*reticulae or fenestrae*)." The fruits otherwise agree with those of *N. Macounii* and without doubt I should refer it to this species.

I have examined the membranes of ripe oospores of both these specimens from Lake St. Clair and St. Clair River collected by J. M. Macoun and find them exactly the same, namely what Groves would call "coralloid" reticulation, i.e. a deeply sculptured but imperfect reticulation, looking rather as if some fish-netting had gone rotten and become broken in many places. I do not consider that Allen's plate correctly depicts the markings as his "elevations" are shown as practically straight whereas they are curled and often joined together with the result that the plate fails altogether to give that suggestion of netting that the decoration clearly presents to me.

The two S. Dakota specimens from Hb Harvard nos. 4009 and 4010 (the New York herb. specimen collected in 1898 from "near Brown's Valley near Wilmot, S. Dakota" but with no collector's name is very likely the same as 4009) though collected by Allen and Saunders do not appear to have been determined by Allen. Groves after examining them noted that he would have referred them to *N. Macounii* but for "the coralloid-reticulate oospore membrane" but I consider his hesitation was unnecessary.

The specimens from French River Mouth and Harbor which I have determined as *N. Macounii* have a striking thick-walled reticulate membrane decoration that apparently represents a more fully formed mesh but as the oospores agree in other respects I have little doubt that they too are *N. Macounii* and that the membrane decoration of this species is reticulate, either coralloid or thick-walled. The specimen in the envelope (vide under *N. dilatata*) which I have concluded is probably from Ottawa River 1895, has a membrane with thick-walled reticulation like no. 4767 from Ontario.

There is one other point about the oospore. Allen's original description gave 5–6 striae whereas in 1894 he gave 7–8 ridges and his figure 4 shows 9. This seems to me rather too high a figure. I should say 5–6 (occasionally 7) is correct.

Allen's dimensions for the size of the oospore are in my opinion too low. He gave them as 210–215 μ long and 200–210 μ broad. I agree that they are

almost spherical but those of the Lake St. Clair specimen which is fruiting freely I should put at c. 275 μ long and 250 μ broad.

12. NITELLA CERNUA Braun in Monatsb. Akad. Berl. 1858, p. 354. Lit.: H. and J. Groves in Symbol. Antill., vol. 7, fasc. 1, 32 (1911) Illustr.: Br. and Nordst., Fragmente pl. 1, figs. 12–19 (1882) K. Giesenhagen, Untersuchungen über die Characeen pl. 3 (1902) Dioecious. Stem extremely stout, up to 2 mm. thick, internodes usually longer than the branchlets. Sterile whorls of 5–8 once-forked branchlets, primary rays stout and much longer than the secondary rays which are 3–5, one-celled, minute, oval with apex acute. Fertile whorls consisting of 1–2 minute heads enveloped in mucus on short stout usually somewhat curved pedicels of which 3–4 usually arise at a stem node; branchlets 6–8, once-forked, primary rays short, secondary somewhat oval and extremely short. Oogonia solitary or 2–3 together, coronula minute. Oospores chestnut-brown or black, 510–620 μ long, 500–540 μ broad with 6–8 thin prominent ridges; membrane very thick, irregularly granulate. Antheridium c. 950 μ in diameter. Distr. West Indies only. Porto Rico, 1887, leg. Sentenis no. 6802; Antigua, 1895, leg. T. B. Blow, 1934 and 1938 (no. 1420) leg. H. E. Box; Marie Galante, 1895, leg. Père Duss, no. 3688; Jamaica, leg. Alexander (hb. A. Braun).

"One of the stoutest and most striking species of *Nitella*" (Groves). The stem and branchlets have usually conspicuous annular incrustation. The only other large homoeoclemous gloeocephalous *Nitella* with one-celled dactyls, *N. praelonga* Br., is monoecious. I have included some particulars of this species as it is not included in Wood's Review but is within the area covered by the North American Flora.

13. NITELLA PRAELONGA Br. The largest known *Nitella*, reaching a length of 6 ft. or more, with the habit, according to Braun, of *N. translucens* and *N. gelatinosa*. Stems extremely stout, 2 mm. or more thick. The 6–8 once-forked sterile branchlets consist of a very long primary, surmounted by 5 minute oval readily deciduous secondary rays. These latter Allen had not actually seen, partly perhaps, as he said, from a desire not to mutilate the few specimens available to him. Fertile whorls take the form of usually 1–3 spikes of 4 whorls, entirely enveloped in mucus, on stout longish pedicels, which abruptly diminish in diameter when the lowest whorl of fertile branchlets is reached, and arising in the axils of the upper stem whorls. The membrane judging from unripe oospores is probably finely granulate but in older states seems to become felted and opaque. A curious feature of the antheridia is that they are situated on short stalks.

This plant has been collected on few occasions. The specimen from Mobile, Alabama, leg. C. Mohr, was presumed by Allen to belong to this species owing to its large size but Groves considered it open to doubt. It is a much more slender plant than the typical form. A further record is a plant I received in good condition from Dr. Wm. Randolph Taylor, collected in 1935 by Elzada U. Clover from near Brownsville, Cameron Co. Texas (Hb. Univ. of Michigan).

Allen's fine plate (1894) depicts the fruiting whorls on somewhat elongated heads on lengthy pedicels but in Clover's plant the heads are shorter and the pedicels short so that the spikes of which 2–4 arise at a stem node, are a good deal shorter than the sterile branchlets. I noticed too on this

gathering conspicuous annular incrustation on the sterile branchlets, as many as 12 bands on a primary ray.

Halsted called this species *N. gelatinosa* var. *gigantea* but that species is one of the Pluricellulatae.

Braun's figure 30 in the *Fragmente* represents the dactyls of the fertile whorls as abruptly narrowed at the apex with a rather obtuse point whereas in the text the words "zugespitzt, wei bei *Belangeri*" are used which would indicate an acuminate apex. In the specimens I have examined, including Clover's from Texas, the apices are acuminate as illustrated in Allen's plate figure 3.

14. NITELLA CAPILLARIS Gr. and B.-W. A slender dioecious light green plant c. 20–30 cm. high, rarely incrusted. Fruits early in the spring and then disappears. This is the only known North American *Nitella* with a tuberculate membrane decoration. Allen gives the length of the oospore as 280–360 μ but I have not been able to check this. The figures in British Charophyta are 375–400 μ. British species too often have conspicuous incrustation.

Evidently a rare plant with a very limited distribution. Writing in 1871 Allen mentioned it as quite common in the small streams on Long Island but by 1894 he stated that repeated search in the cold streams near Hempstead, L. I., the original locality, failed to rediscover it. A similar state of affairs has occurred in Britain. In its only locality it has not been recorded for 50 years.

15. NITELLA BASTINII Allen. A dioecious rigid plant c. 20–30 cm. high (Allen's "2–3 cm." is presumably a misprint). There is but a single gathering for this species and the locality, the site of the World's Fair, Chicago, is now destroyed. Allen described it as having 8–12 once-forked branchlets but I cannot detect more than 5–6 in dried specimens and Allen's plate does not show more than five. The 2–3 one-celled secondary rays are short and very unequal in length. The fertile whorls, with very short branchlets and forming heads at intervals, were described as enveloped in mucus but as is not infrequently the case I have not been able to detect any clear trace of mucus in the only dried specimens I have seen.

It should be readily distinguishable from *N. capillaris* by the very short dactyls and the entirely different membrane decoration. The membrane decoration of *N. Bastinii* is undoubtedly reticulate, finely I should say, with meshes perfectly formed though varying much in size and shape, c. 14 meshes to the fossa, a good deal finer mesh than is shown in Allen's plate figure 5.

N. Macounii is the only other North American *Nitella* with one-celled dactyls that has a reticulate membrane decoration but its netting is of a deep coralloid type unlike the fine mesh of *N. Bastinii*.

16. NITELLA MUCRONATA Miq. We now come to species with the dactyls consisting of more than one cell. *N mucronata* is a medium sized plant of strong erect habit, often rather bushy. There is frequently some difference between the sterile and fertile whorls, the latter tending to form heads; branchlets 2–3 times forked.

An extremely variable species, with some forms not unlike *N. oligospira* but typically *N. mucronata* has only 2–3 rays at the second fork with no very short dactyls and a rather larger and darker oospore and in *N. oligospora* the oospores are only produced singly whereas in *N. mucronata* they may be single or geminate.

The dactyls of *N. mucronata* are nearly always 2-celled, occasionally appearing as 3-celled though this may be only due to suppressed forking. The lower cell is usually rounded at the apex, with the base of the end-cell smaller than the apex of the lower cell so as to form a conical acute mucro. Two other arthrodactylous species with a reticulate oospore membrane, *N. tenuissima* and *N. pygmaea,* are both considerably smaller than *N. mucronata.*

N. mucronata has been found on few occasions in North America. Allen (1896) mentions several varieties but var. *virgata,* an elongated form with geminate oogonia, more frequent 3-celled dactyls and a yellow-brown oospore, seems to be considered the only one worth retaining.

17. NITELLA GRACILIS Ag. A decidedly slender very graceful small plant, usually from 12–20 cm. high. It somewhat resembles small forms of *N. mucronata* in general appearance but is usually more forked with 3–4 tertiary rays (as against 2–3 in *N. mucronata*), frequently has 3-celled dactyls (only occur occasionally in *N. mucronata*) with the apex of the penultimate cell much less rounded than in *N. mucronata* and not much broader than the base of the end-cell, so that this latter cell does not form the conspicuous mucro that is typical in *N. mucronata;* finally *N. gracilis* has a granulate oospore membrane in marked contrast with the reticulate pattern of *N. mucronata.*

Apparently an uncommon North American plant. To the few records I should add the plant collected by Allen in Aug. 1880 from Apponang, Rhode Island, which he first determined as *N. gracilis* and then changed to *N. intermedia.* A similar plant was collected by T. Morong from the same locality on August 25th 1881 and determined by Allen as *N. intermedia.* They do not have the characteristic look of *N. intermedia* and produce frequent 3-celled dactyls of which the middle one is decidedly tapering.

Allen's dimensions for the oospore are slightly smaller than in British specimens. He also puts the striae at 6–7 whereas British forms have generally 5–6.

18. NITELLA CAPITELLATA Br. This species appears closely related to *N. gracilis* both in appearance and in the occurrence of frequent 3-celled dactyls. Judging from figure 43 in the *Fragmente,* this is a largish plant. It is not represented in the New York herbarium and the only specimens in herb. Mus. Brit., two pieces of Weinland's gathering from New Hampshire (ex. hb. Braun), show small slender plants that might easily be taken for *N. gracilis.*

N. capitellata is less forked however than *N. gracilis;* in fact the sterile branchlets being only once-forked seems to me a marked characteristic; the branchlets of the fertile whorls are usually only twice-forked whereas in *N. gracilis* all the branchlets have 2–3 forks. The oospores too are dark brown, according to Braun black. The point selected by Nordstedt in the *Fragmente* Key to distinguish the two species does not strike me as a very good one. *N. capitellata* is alleged to have 5 prominent striae to the oospore and *N. gracilis* 6 scarcely prominent. The authors of *British Charophyta* give the striae in *N. gracilis* as 6, though in the plate only 5 are depicted, and the striae are described as rather prominent and are so figured. The membrane decoration of *N. capitellata* has not been recorded nor the size of the antheridium.

19. NITELLA TENUISSIMA Kütz. (= *N. transilis* Allen). A minute plant, varying in height from 5–10 cm., with a very slender (250 μ in breadth) strong stem and internodes up to 5 times the length of the branchlets. The short branchlets, up to 4-times furcate, and the distant whorls generally give this species a very distinct look. The first fork is normally sterile, there being usually a central ray in the place where one might expect an antheridium.

In West Indian specimens, as noted by Groves, there is often an antheridium at the first fork and the membrane decoration instead of the typical beaded reticulation is rather imperfect with "beads" only at the angles, being thus more or less coralloid in nature. Nordstedt also noted the presence of this antheridium in C. Wright's specimens, nos. 57 and 59, from Cuba. There is very little branching in this species and the plants are often densely lime-incrusted.

Allen considered there were some transitional forms between *N. gracilis* and *N. tenuissima*, to which he gave the name *N. transilis*, with longer branchlets so that the internodes do not appear specially elongated. He gave the membrane markings of the three gatherings that he referred to his *N. transilis* as varying from perfectly smooth to reticulate but for a membrane really to vary in this way hardly sounds likely. The reticulate membrane decoration in Allen's plate of *N. transilis* appears to me typical of *N. tenuissima*.

Groves doubted whether there was sufficient ground for the separation of *N. transilis* and I feel quite satisfied that there is not. Allen moreover found larger forms of *N. tenuissima* with longer branchlets that approached his intermediate species which indeed he only hesitatingly created.

N. tenuissima is clearly distinguishable from *N. gracilis* by its oospore membrane alone.

Var. *compacta* Br. from Texas and Cuba, with branchlets only twice-forked, is a very low growing plant that forms a thick turf-like mass.

20. NITELLA PYGMAEA Br. This minute species, c. 5 cm. high, is based on a single gathering in Mexico in 1843. In Nordstedt's Key in the *Fragmente N. pygmaea* is placed next to *N. confervacea* Br., separable by the aggregate oogonia (2–3), and is distinguished from *N. tenuissima* by bearing oogonia only at the first fork, usually two oogonia and one antheridium. The reticulate oospore membrane in *N. pygmaea* also distinguishes it clearly from *N. confervacea;* the mesh, being fine, is quite different from that of *N. tenuissima* which is bold and in its mature stage beaded.

21. NITELLA CONFERVACEA Br. (= *N. batrachosperma* Br.). Another minute plant, up to c. 5 cm. high, and very rare in North America. It may perhaps be overlooked if it grows in deep water; in Ireland it is found in 4–6 ft. of water.

Somewhat similar to *N. tenunissima* in appearance but with reproductive organs at the first fork, whorls of usually 8 branchlets (as against 6 in *N. tenuissima*) and a granulate oospore membrane. (The authors of *British Charophyta* (1,125) inadvertently spoke of the membrane tending to become reticulate. This is contradicted on the next page, and plate 5 figure 6, which is a better representation of the decoration than plate 15 figure 9, does not in the least suggest this pattern). *N. confervacea* is also less forked than *N. tenuissima*.

Allen in his earliest paper (1871) spoke of having received a specimen

of this species from Mr. C. C. Frost of Brattlesboro, Vermont, and included it as an American species in his Synopsis (p. 46, 1888) but the species is omitted from his Revised Synopsis (p. 19, 1896) and when describing his *N. minuta* he referred to *N. batrachosperma* as a European species. I have not been able to see any such specimen collected by Frost.

Morong's plant from Nantucket, Mass., was included by Nordstedt under this species but Allen who at first assigned it to this species and later to a form of his *N. minuta*, finally considered it distinct from both. Tilden's plant (*Amer. Algae*, 530) collected on August 15th, 1901 near Duluth, Minnesota, is stated on label to have mostly 5–6 branchlets but from a scrap on a slide I should say there were more; one cannot tell for certain without carefully dissecting it.

Among Groves's slides of this species is one marked Macoun 8, (1903) but with no data, and another from Lake Co., California, coll. J. W. Blankinship. There is also the recent record by Mrs. Daily of Kiener's gathering, 10641a, in Nebraska in August 1941; this I have not seen. The membrane, she says, shows interrupted reticulation but the description otherwise and illustrations certainly indicate this species. The name *N. batrachosperma* Br. being invalid, a new one had to be selected. Hy, the French authority who made a special study of the point, found the presence of mucus in *N. batrachosperma* was not a constant character and considered it the same as the earlier published species *N. confervacea* Br. Groves and Bullock Webster evidently accepted this view but not considering the name *N. batrachosperma* invalid retained it. I have not noticed any trace of a mucous covering to the gametangia in the few North American specimens I have seen and hence consider *N. confervacea* Br. the correct name.

22. NITELLA LEIBERGII Allen. A very small monoecious plant, c. 3–4 cm. high, with a marked heteromorphous character. Allen placed it in his subsection "*diffusa*," to distinguish it from his "*congestae*" with their fertile whorls in dense axillary heads, such as *N. Morongii*, *N. axillaris* and *N. annularis*, but admitted that it exhibited a marked tendency to the "*congestae*."

N. Leibergii has a decidedly stout stem (c. 400 μ broad) for its diminutive size, being twice as thick as that of *N. confervacea*. It has 6 branchlets compared with usually 8 in *N. confervacea*.

The only record for this species hitherto has been the original one collected by J. B. Leiberg in June 1894 from Eastern Oregon. A plant I examined from the Farlow Herb., Harvard Univ., collected by J. W. Blankinship (no. 5) at Wagoner, Oklahoma, on August 21st, 1895 was referred by me to this species. In this plant, which looked much more slender than Leiberg's, the oospores were warm brown in color and the membrane granulate.

23. NITELLA MINUTA Allen. A minute tufted monoecious plant found by Allen in Green Pond, New Jersey, in September 1883. He gave the height as 2–6 cm. high but having seen the type I should put it at the latter figure. The stem is extremely slender, 130 μ in diameter.

The sterile whorls consist apparently of 6 once- or twice-divided branchlets, up to c. 2 cm. long. Fertile branches are in "small globular masses" enveloped in mucus, far overtopped by the sterile branchlets. The oospores are dark reddish-brown and the membrane granulate, the granules being oval elongated and elevated, c. 9 to the fossa.

N. minuta much resembles *N. confervacea* but differs mainly in the reproductive organs being enveloped in mucus, the branchlets being 6 (as against 8), the heteromorphous character and the rather larger oospores, 350 μ long and 285 μ broad (as against 225–300 μ long and 200–250 μ broad), which are darker in color.

Allen found the membrane markings somewhat difficult to determine but considered the granules to be "irregular, oval or elongated elevations." As they require considerable magnification membranes are often difficult to make out. To me it appeared to be finely and evenly granulate; I have not been able to see any markings very similar to Allen's etching.

Allen described the branchlets of the sterile whorls as "filiform" but by this term he must simply have meant that they were very slender and not that they were undivided seeing that in fact they are once or twice forked as can be seen from his illustration.

24. NITELLA INTERMEDIA Nordst. A smallish diffuse plant, c. 10 cm. high, with internodes the same length as the branchlets. Dactyls long and almost invariably 2-celled, a tertiary dactyl being sometimes 3-celled, probably through suppressed forking, the lower cell of even width throughout and the end-cell a narrow elongated mucro with the base about as wide as the apex of the lower cell.

N. intermedia is a particularly slender graceful plant, resembling an enlarged *N. gracilis*, Allen's "nat. size" illustration of the plant except for being rather on the small side giving a very good idea of it. It does not seem to vary much, all the specimens I have seen being very similar.

The gloeocarpous character is not very obvious, being only apparent in the young whorls but may often show itself under the microscope from the amount of extraneous particles adhering.

N. intermedia is distinguishable from *N. tenuissima* by the shorter internodes, the presence of mucus, the larger blackish oospores, oogonia at all forks and longer diffuse branchlets; from *N. gracilis* by mucus, shorter internodes, larger oospore and 2-celled dactyls; from *N. confervacea* by its larger size, longer more diffuse branchlets, often thrice forked, and larger oospore and antheridium.

Nordstedt described the colour of the oospore as *"atro-badio"* i.e. dark reddish-brown which is just what I found; he said he had only seen one mature oospore but there were several on the freely fruiting specimen that I examined. He mentioned as one of the features of his species distinguishing it from *N. gracilis* the greater prominence of the oospore ridges but he described them in the words "striis paullum prominulis" and I should have said that the ridges were less prominent in *N. intermedia* than in *N. gracilis*.

In addition to the records cited by Wood (1948) I would add Lake Chocorua, New Hampshire, 8 Aug. 1918, leg. Huron H. Smith (Hb. Harvard); Caroga Lake, Fulton Co., New York, 17 Aug. 1934, leg. W. C. Muenscher (no. 342); Canada Lake, Fulton Lake Co., N. Y., 19 Aug. 1934, leg. Muenscher (no. 344), (342 and 344 both very good specimens), Long Lake, N. Y., 24 Aug. 1933, leg. Muenscher, White Lake, Sullivan Co., N. Y., 6 Sept. 1935 leg. Muenscher (no. 368).

25. NITELLA ASAGRAYANA Nordst. A rather small monoecious plant c. 15–20 cm. high, with a slender stem and internodes about as long as the branchlets. Sterile whorls of 5–6 twice- (very rarely thrice-) forked branch-

lets with long primary rays c. $\frac{1}{2}$–$\frac{2}{3}$ of the total length of the branchlet; secondary rays 4; tertiary 3, much shorter than the secondary, 2-celled, the end-cell a sharp mucro which according to Allen is very inclined to be deciduous. Fertile whorls in longish or oval contracted heads which are enveloped in mucus, on long stalks in the upper axils of the plant; branchlets twice, occasionally thrice, divided. Oospore rich golden brown, c. 325 μ long and 235 μ broad with 5–6 ridges. Membrane decoration not known as only found in felted condition.

A poorly mounted example in the New York herbarium shows that the fertile heads, 2–3 in number, arise in the upper axils and form a marked contrast with the large sterile branchlets but as mentioned by Allen some of the upper large branchlets bear some reproductive organs.

Nordstedt's dimensions for the end-cell as 600–750 μ broad and 120–150 μ long are presumably transposed.

The oospore dimensions as found by Groves are rather higher than those given by Allen. The mucus may not be very obvious as in specimens seen by Groves little or none was apparent.

The year of Schaffner's Mexican gathering, the only known specimen, is stated by Allen to be 1876 but according to labels I have seen quoted it is 1875.

The conspicuous small fertile heads of *N. Asagrayana* render it strikingly different from *N. intermedia*.

26. NITELLA ANNULARIS Allen. A smallish but fairly robust looking plant c. 20 cm. high. The original description of this species, of which there is but the one record by Pringle in Mexico in 1888, does not state whether it is monoecious or dioecious. Allen's magnified figure 2 rather suggests dioecious but in his Revised Synopsis (1894, p. 8) it is classed as monoecious and this I have confirmed under the microscope; with dried material it is not always easy to detect antheridia or make out their position.

The colour of the oospore is a warm brown. Allen gave the dimensions as 280 μ long and 260 μ broad; I should put them rather lower than this as c. 240 μ long and 220 μ broad.

Allen describes the sterile leaves as surmounted by a crown of three leaflets which are elongated; the branchlets are usually once forked into 2 terminal rays which do not suggest to me anything in the nature of a crown.

The dried material does not admit of an exact elucidation of the strange fruiting portions of the plant. These take the form of a number of complicated little heads on an axis that arises apparently from the axil of a sterile whorl. This axis is divided at least once or twice, like a miniature tree, and from its upper nodes are produced clusters of spikes which consist of several whorls of 6 once-forked branchlets with 2-celled dactyls, the oogonia (3 together) being borne at the branchlet nodes. The spikes have internodes shorter than the branchlets and are hence very congested. Allen's plate will be found very helpful.

Another very peculiar feature of this plant is the production at both stem and branchlet nodes of a ring of roundish swollen nodal cells. Allen attributed to this peculiarity the very early dropping off of the terminal rays and sometimes whole branchlets. The end-cell of the dactyl too is very prone to fall off.

27. NITELLA MORONGII Allen. A small distinct looking plant c. 15 cm. high with, at any rate in the earliest gathering by Rev. Thos. Morong on

Nantucket in July 1887, very conspicuous spikes c. 1½ cm. long as depicted in Allen's original plate 75 (1887), though later gatherings, as pointed out by Wood in his "Emendation of *Nitella Morongii*" (Rhodora, vol. 51, 13, 1949), do not exhibit them so well developed.

Allen described this plant again in his Synopsis (1894) with a further plate. The striae were originally said to be fairly prominent but not so depicted; in the later description they are said to be prominent, as well shown in the accompanying plate.

The fertile spikes in the earlier illustration look rather like fern fronds and appear to consist of about 12 fruiting whorls with 6 short twice-, occasionally thrice-, or in upper whorls once-, forked branchlets.

Nordstedt considered the membrane to be felted, a condition that obscures the true markings, whilst Allen thought it minutely granulate.

N. Morongii has a very restricted range, being only recorded from Massachusetts. It comes very near *N. axillaris* but in this latter species the fruiting heads are axillary only, the oospores larger with the membrane reticulate and the dactyls on the sterile branchlets minute.

28. NITELLA AXILLARIS Br. A plant that rather resembles the European *N. translucens* Ag. in its long sterile once-forked branchlets with minute 2-celled dactyls and its little axillary fertile heads. *N. axillaris* is however considerably smaller and more slender and the fertile heads are always axillary (not terminal) and the oospores are smaller. Not having himself seen specimens Allen included a translation from the *Fragmente* where the fertile whorls are described as minute axillary heads but in his Synopsis Key (p. 9, 1894) he mentioned, apparently inadvertently, that the fertile whorls were both terminal and axillary.

The combination of 2-celled dactyls, reticulate oospore membrane and sterile branchlets only once-divided distinguish it from all other North American species. I agree with Wood in dissenting from Zaneveld's view (p. 70, 1940) that *N. axillaris* and *N. Morongii* are probably the same species, the dactyls of the sterile branchlets being for one thing quite different. *N. axillaris* seems to be a subtropical species, nearly all the records being from Mexico, Costa Rica and the West Indies.

29. NITELLA OLIGOSPIRA Br. This is one of the three North American representatives of the section Brachydactylae; they are all monoecious. A characteristically tropical species. *N. oligospira*, which occurs chiefly in the southern part of North America, is a medium sized diffuse plant, usually c. 20 cm. high, with no difference between sterile and fertile whorls.

There is much forking, sometimes four times, with many rays at the first and second forks. Reproductive organs usually produced at the 2nd and 3rd forks, with very rarely an oogonium even at the first. The oogonia are solitary, oospores rather pale brown with the membrane clearly but somewhat irregularly reticulate.

The Brachydactylae normally have uniformly short divergent clusters of dactyls but as Groves has remarked "this variable and rather indeterminate species seems to occupy an intermediate position between the sections Macrodactylae and Brachydactylae." It always has some short dactyls but by no means are all of them so.

It may not always be easy to distinguish *N. oligospira* from tall much forked forms of *N. mucronata*, in which an occasional short dactyl may be found and the oospore membrane is also reticulate. Important differences

between them are that the tertiary rays in *N. mucronata* are normally only 2–3 whereas in *N. oligospira* they are more numerous (3–5) and the ripe oospores of *N. mucronata* are dark brown instead of pale brown as in *N. oligospira*.

I am including under *N. oligospira* the species described by H. and J. Groves in 1897, as *N. dictyosperma* from a plant collected in Antigua by T. B. Blow and later found in other parts of the West Indies as it does not differ sufficiently and probably came to be so considered by Groves later on. In this form the occurrence of a short dactyl is less common than usual in *N. oligospira*. In a similar specimen I recently examined from Trinidad collected by Senior White in 1950, many of the tertiary dactyls were 3-celled, evidently from suppressed forking, and the very small dactyls were not numerous but some of the smallest seemed to me to be only 1-celled.

Var. *Wrightii* Br. does not seem to me to have any special characteristics and might well be dropped in my opinion.

30. NITELLA MICROCARPA Br. A robust plant with wide spreading branchlets, something like a very stout *N. mucronata*, originally described from gatherings in Dutch Guiana and Panama. The very short dactyls usually occur mostly on the younger and fertile parts of the plant and are sometimes not numerous.

One characteristic feature of this species is the aggregate oogonia, us. 2–4, but occasionally solitary. Another marked feature is the small size of the oospore. Braun's original description gave the length as 180 μ but several specimens have been referred by Groves to this species with rather larger ones; I should therefore put the length at 180–270 μ. Groves found oospores on the original Panama plant exceeding 250 μ in length.

H. and J. Groves distinguished a var. *Wrightii* from a Cuba specimen collected by C. Wright (3921 pro parte) in 1865 in which the dactyls, rarely short, tapered so as to resemble those of *N. acuminata*. I have seen a specimen and cannot consider this variety of much importance.

Similarly var. *Glaziovii* (Zeller) Zaneveld is separated principally by the larger oospores but the length given (240–280 μ) would practically fall within what I consider the limits for *N. microcarpa*. A Groves manuscript note runs "only separated in the key by the doubtfully larger oospores."

31. NITELLA MEGACARPA Allen. A large robust plant collected by Allen in 1880 in Connecticut and discribed on the label of his Char. Amer. exsicc. 3. I consider that Allen undoubtedly meant to designate it as a species and that his inclusion in the description of the words "subspecies *N. polyglochcin* A. Br. *sensu latiore*" simply meant that it was one of the Brachydactylae, an important feature which would otherwise be without mention.

It comes nearest to *N. microcarpa* of which it has been regarded as a subspecies or a variety but the very much larger oospore, as also antheridium seems to me to entitle it to specific rank. Allen's dimensions for the oospore are 400–530 μ long though I should say 370–450 μ while I should put the corresponding figures for *N. microcarpa* at 180–270 μ. The 400 μ diameter of the antheridium of *N. megacarpa* compares with 200–270 μ for *N. microcarpa*.

Allen described the oospore as black which is hardly correct. Groves has a manuscript note "It seems to me that the bright orange-brown of his own original plant and that from Asheville, N. Carolina, is a distinctive character." This beautiful oospore is to be found in other specimens also. I

agree with Nordstedt who considered the oospore membrane to consist of granules that were often free but arranged net-wise. I should call it a fine (c. 15 meshes to the fossa) but not a perfect reticulation as the meshes are not always complete.

The branchlets are 4 times forked, the rays at each fork exhibiting extreme irregularity in length.

There are a number of plants from various parts of New York State collected by W. C. Muenscher and A. A. Lindsey between 1931 and 1935 (Hb. Cornell Univ.) and one from near Woods Hole, Mass. leg. Palmer and from Michigan leg. Beckman (no. 180) (Hb. W. R. Taylor) in 1936 that I have referred to this species. There are also records from N. and S. Carolina and Oklahoma.

32. NITELLA CAPILLATA. Br. The only North American representative of Braun's group, Polyarthrodactylae, or, as Groves would style it, one of the Pluricellulatae of the Homoeoclemous Arthrodactylous group.

A monoecious plant of medium height (c. 25 cm.), with sterile branchlets up to 4-times forked and with many rays at the forks, whilst the small fertile whorls are produced on gelatinous spikes in about 5 interrupted little heads, the branchlets usually twice-forked and the dactyls consisting of 3–4 cells, the lowest slightly the largest and the end-cell generally bluntish. The antheridium is situated on an appreciable stalk.

N. capillata is beautifully illustrated in the *Fragmente,* t.2, figures 64–68, and fully described.

About ninety years have elapsed since the original record of *N. capillata* from New Orleans; it has been found again by Dr. Whitford in N. Carolina and lucidly described by Mrs. Daily with illustrations. It is specially interesting to know from this second gathering that the oospore is dark brown, c. 220 μ long and c. 200 μ broad i.e. subspherical, with c. 8 striae, the membrane exhibiting a bold reticulation with only c. 4 meshes to the fossa.

33. NITELLA CLAVATA Kütz. A tall monoecious plant, reaching to 35 cm. or more, with a stout stem and the whorls of short branchlets forming roundish heads, whorls being at long intervals in the lower parts of the stem.

N. clavata is a very distinct species, being heteroclemous, i.e. the whorls consisting of two different kinds of branchlets; the primary, 6–8 in number, are once-forked and fertile whilst the secondary, which are simple and sterile, arise below the primary set and alternate with them. The secondary 1-celled dactyls, usually 2–3, are very short and stout, nearly spherical in extreme cases (var. *inflata*), with a mucronate apex.

The nearest North American plant is *N. hyalina* but this latter has 2-celled dactyls.

Essentially a Pacific Coast species, as Allen pointed out, but occurring also in San Domingo and Quebec. Not recorded elsewhere than from North and South America.

34. NITELLA HYALINA Ag. A tall heteroclemous monoecious plant, reaching to c. 30 cm., with internodes 2–4 times the length of the branchlets. The whorls normally consist of 8 primary branchlets, 2–3 times furcate, and c. 16 shorter and simpler secondary branchlets occurring in two series, one above and the other below the primary branchlets, the upper series us. once forked into c. 5 rays and may be simple, the lower once or twice forked into 4 rays. Gametangia, generally enveloped in thick mucus, occurring mainly

at the 2nd and 3rd fork of the primary branchlets and sometimes also on the accessory.

Ernst (Zurich, 1904) has shown clearly the origin and development of the accessory branchlets. Migula's figure 56c in *Die Characeen* showing pairs of neat little secondary branchlets does not, as Groves has remarked in manuscript, appear to accord wth facts. Groves considered them to be quite indifferent, either opposite or alternating with the primary.

I may mention that there is a slip in *British Charophyta* 1.128 where it is stated that the outer membrane is obscurely reticulate. This is contradicted lower on the same page; the decoration is finely granulate as shown in plate 5, figure 7.

A rare species in North America. In addition to Mexico, North Carolina and Texas, it occurs in Cuba and Dominican Republic (leg. R. M. Bond in March 1933).

TOLYPELLA

Branches as many as eight or more at a stem-node as compared with normally two in *Nitella*. Sterile branchlets either simple or forked. (The so-called "forking" is not of the same nature as in *Nitella* since there is always a stout central ray, from a node of which are produced rays best termed laterals).

Fertile branchlets forked, the lateral rays being very unequal. Antheridia and oogonia are both produced laterally at the nodes of the branchlets and often also at the base of the whorl. (In *Nitella* the antheridium is always terminal in a branchlet fork). Oogonia clustered. Oospore circular is cross-section.

The main features that distinguish *Tolypella* from *Nitella* are the lateral position of the antheridium, the ripe oospore not being flattened, the very unequal length of the laterals of a fertile branchlet, the constant monopodial growth of the branchlet and, most conspicuous of all, the numerous branches.

The fruiting whorls generally form dense heads, the so-called "birds'-nests," from the numerous often incurved rays. By the time ripe oospores are available the plant is often beginning to disintegrate. In *Tolypella* there is not the variety of membrane decoration that occurs in *Nitella*, most of them being granular if anything.

The absence of flattening in the oospore and the monopodial growth of the branchlets form a link with the *Chareae* but as the coronula consists of two tiers it belongs to the *Nitelleae*.

Species of *Tolypella* are usually classified mainly by the shape of the ultimate cell of the rays which may be either conical or sausage-shaped (allantoid) and by whether the sterile branchlets are simple or produce laterals.

All North American species are monoecious, the only known dioecious species being the Mediterranean *T. hispanica* Nordst. Dr. T. F. Allen devoted particular attention to this genus.

Tolypella is a particularly difficult genus to study especially with herbarium specimens as in general aspect they tend to look much alike.

Apart from being very sporadic in their appearance their individual season is often very short, perhaps a matter only of three weeks or so, and to be sure of determination one requires both young specimens and ripe fruit.

KEY TO TOLYPELLA

1. Obtusifolia. Coronula deciduous. Sterile branchlet simple.
   A. Ultimate cell of sterile branchlet longer than the other cells ..... 1. *T. longicoma*

B. Ultimate cell of sterile branchlet shorter than the other cells
Oospore 300–360 μ long ..... 2. *T. glomerata*
Oospore 425–475 μ long ..... 3. *T. comosa*
2. Acutifolia. Coronula persistent.
A. Sterile branchlets simple ..... 4. *T. prolifera*
B. Sterile branchlets divided (usually into 4 rays)
a. Lateral rays of fertile branchlets simple
Rays 4–6 (–7 in sterile branchlets)-celled ..... 5. *T. californica.*
Rays 3–4-celled ..... 6. *T. stipitata*
b. Lateral rays of fertile branchlets divided
Oospore 450–475 μ long ..... 7. *T. intertexta*
Oospore 360–425 μ long ..... 8. *T. intricata*

1. TOLYPELLA LONGICOMA Br. Lit. Allen, Bull. Torrey Bot. Club 10: 110 (1883) Illustr. Fragmente, pl. 2, figs. 69–73. Stem up to 480 μ in diameter. Sterile whorls of 6 elongated simple 3-celled (probably) branchlets c. 40 mm. long, the ultimate cell elongated, longer than either of the lower two and cylindrical, the apex obtuse. Fertile whorls in dense compound heads of 6 or 7 once-divided branchlets; primary ray very short; laterals usually 3, unequal, curved, the central ray much the longest, all 3-celled; of the central ray the middle or even the lowest cell the longest, ultimate cell long cylindrical with an obtuse apex. Oogonia and antheridia at the branchlet nodes. Oogonia usually 3 together, occasionally with short stalks; spiral cells swelling at the apex. Oospore brown, 360–400 μ long, 300–320 μ broad, showing 9 not very prominent striae. Antheridium 360 μ in diameter.

Distr. Swamps near Columbus, Ohio (comm. Lesquereux, 1885): Cayuga Lake, Ithaca, New York, June 1921 and 1922 leg. R. Hitchcock.

As Braun remarks, this species is related to *T. glomerata* which it much resembles. He notes as points of difference in *T. longicoma* its compact tufted growth, thin delicate stem and branchlets, absence of all incrustation and its flexibility.

Nordstedt in his key in the *Fragmente* gives as the outstanding difference the fact that the ultimate cell of the primary ray of the branchlet is longer than the other cells. This presumably refers to the ultimate cell of the simple sterile branchlets as, further on, Braun distinctly states that in the fertile whorls the middle or even the lowest cell of the long terminal ray is the longest.

Braun describes *T. longicoma* as forming dark green thick tufts a hand high. Hitchcock found it in abundance up to a depth of four feet covering the bottom in tufts about 15 cm. tall.

Nordstedt did not see any ripe oospores and so could not determine the membrane decoration. The oospores seem to be rather larger than those of *T. glomerata* but smaller than those of *T. comosa;* both these species are usually heavily lime-incrusted, a fact that should help in distinguishing the present species.

2. TOLYPELLA GLOMERATA Leonh. Lit. Fragmente, 95; Migula, Die Characeen. 227: Allen, Bull. Torrey Bot. Club, 10: 111 (1883); Groves and Bullock-Webster, Br. Char. 1: 135. Illustr. Migula l. c. fig. 64; Groves in Journ. Bot. 18; pl. 209, fig. 11 (1880): Gr. and B.-W., l. c. pl. 19, pl. 5 figs. 8 and 9 (membrane): Nordst. De Algis pt. 4. pl. 1, figs. 41–43 (membrane): Allen, l. c. pl. 37 (var. *abbreviata*) 1883. Stem medium size: branches 2–6 at a node. Sterile whorls of 6 to 12 elongated simple 3–5-celled branchlets, the ultimate cell shorter than the others and cylindrical with

obtuse apex. Fertile whorls in dense compound heads of once-divided branchlets: primary ray rather short: laterals 4 to 5, unequal, often tapering, strongly incurved, the central ray much the longest, lateral rays usually 3-celled: cells of all rays progressively shorter, ultimate cell fairly long, cylindrical with an obtuse apex. Oogonia and antheridia at the node of the branchlet and oogonia sometimes in great number at the base. Oogonia usually 2–6 together, often stalked, spiral cells swelling at the apex: coronula deciduous. Oospore orange-brown or cold dark brown, 300–375 μ long, 250–290 μ broad, showing 7–9 thin low ridges, membrane linearly granular. Antheridium 325–375 μ in diameter.

Distr. West Okoboji and Spirit Lakes, Iowa (rec. 1924), L. Sawyer: Santa Cruz River, S. W. Arizona, 1881 and 1882 leg. Pringle: Canada, West of the Saskatchewan, Aug. 1881, leg. Macoun. "A very variable species, usually of medium stature and tufted growth and generally completely incrusted." "The conspicuously curved rays give it a very distinctive appearance." (Gr. and B.-W.)

T. glomerata with its wide range (Europe, Asia, Africa and Australia) is surprisingly rare in N. America. Both Pringle's and Macoun's plants have been styled var. *abbreviata* by Allen on account of the branchlets being exceptionally short. Macoun's plant differs from the typical form in being entirely unincrusted and the oospore only showing six striae. Sawyer's too is quite free from lime.

Nordstedt has given three drawings of the membrane decoration from specimens from different places: figure 43 depicts Pringle's and shows, perhaps in a rather exaggerated form, the linear arrangement of the granules. Although Nordstedt in taking up the study of membrane decorations made an enormous stride, some of his drawings Bullock-Webster thought rather crude.

3. TOLYPELLA COMOSA Allen in Bull. Torrey Bot. Club 10: 112 (1883). Illustr. Allen l. c. pl. 38. Exsicc. Allen, Ch. Amer. 35. Stem slender, 360 μ in diameter: branches apparently usually 3 at a node. Sterile whorls of about 7 much elongated simple 3-celled branchlets, the ultimate cell shorter than the others and cylindrical with obtuse apex. Fertile whorls in congested heads of once-divided branchlets: primary ray rather short: laterals usually 4, unequal, somewhat tapering, incurved, the central ray much the longest, all 3-celled: cells of all rays progressively shorter, ultimate cell fairly long, cylindrical with obtuse apex. Oogonia and antheridia at the nodes of the branchlets, oogonia also produced sparingly in the fundus at the base of the whorl. Oogonia usually 2 with an antheridium, occasionally one oogonium and 2 antheridia, at the branchlet node: spiral cells not swelling at the apex: coronula deciduous. Oospore dark brown, 425–475 μ long, 320–360 μ broad, showing 7–8 somewhat prominent striae. Membrane faintly granular. *Antheridium* sessile, 400–425 μ in diameter.

Distr. Near Geneva, Seneca Lake, New York, Aug. 1882, T. F. Allen, growing with *T. intertexta* at a depth of about ten feet.

A slender little plant, 5 to 10 cm. tall, resembling the European *T. nidifica* but smaller and with smaller antheridia. Considerably smaller than *T. glomerata* and with less branches arising at the stem whorl. It is thickly lime-incrusted. Allen gives as one point of difference from *T. nidifica* its having a persistent coronula but distinctly says *T. comosa* has a diciduous coronula and in a foot-note points out that species with an obtuse apex to

the branchlet all have a deciduous coronula and those with an acute apex a persistent coronula.

Curiously enough, Allen who as a rule takes special pains to study the question, does not say anything about the membrane decoration. Nordstedt has described it and remarks that as in *T. glomerata* var. *abbreviata* the pits (*gruben*) are not always in rows but scattered and often scarcely, or not at all, visible. Groves also examined the membrane and has left a manuscript note that Nordstedt's remarks agree with his own experience. There seem to me to be some minute scattered granules that perhaps tend to form lines but a good deal of the surface is plain.

4. TOLYPELLA PROLIFERA Leonh. (= *T. fimbriata* Allen). Lit. Fragmente, 97: Allen, Bull. Torrey Bot. Club 10: 112 (1883): Migula, Die Characeen, 203: Groves and Bullock-Webster, Br. Char. 1: 133. Illustr. Allen l. c. pl. 39 (as *T. fimbriata*): Migula l. c. figs 59–60: Gr. and B.-W. l. c. pl. 18. Stem very stout, often solitary with ten or more branches arising from the lowest whorl. Sterile whorls of 6–20 simple 3–5-celled unequal branchlets, the cells diminishing in length and breadth towards the apex, end cell conical. Fertile whorls in large densely crowded heads; branchlets with 1 (rarely 2) node; laterals usually 3 with one central ray which if not again divided is many times the length of the laterals; ultimate rays 3–5-celled, cells much diminishing in length and breadth, end cell conical, usually acute but sometimes rather blunt. Oogonia and antheridia at the branchlet node and at the base of the whorl. Oogonia aggregate, coronula prominent and persistent, the upper tier of cells much the longer. Oospore chestnut coloured, 330–400 μ long, 250–330 μ broad, showing about 9 very thin prominent often flanged ridges. Membrane with no decoration. Antheridium usually sessile, c. 300 μ in diameter.

Distr. Many records inc. Upper Missouri, Illinois, Colorado, N. Dakota and in Canada, from Saskatchewan, Lake Huron and British Columbia: (as *T. fimbriata*) from Lake Ontario and Ithaca, N. Y.

A large robust species about 20–35 cm. tall. The very stout stem and the large number of branches originating from the lowest whorl give it, as Groves and Bullock-Webster say, a peculiarly tree-like aspect. According to Allen it is rarely incrusted but British specimens are usually much incrusted.

Allen described *T. fimbriata* as a separate species, distinguishing it from *T. prolifera* mainly on the ground of its smaller size, its larger oospores and prominent striae. In his key he gives 350–375 μ as the oospore length in *T. prolifera* and 425–450 μ for *T. fimbriata*. The limits for *T. prolifera* in *British Charophyta* are 330–400 μ and Groves has left a manuscript note "the specimens of type *fimbriata* I have examined do not exceed 400 μ."

In that same work the striae are described as "very thin prominent often winged ridges." They appear to me to be perhaps slightly more prominent than in N. American specimens of *T. prolifera* which Allen describes as "inconspicuous."

Two specimens of "*T. fimbriata*" in the New York herbarium from Ithaca, N. Y., I found to be 37 and 45 cm. tall: they certainly looked indistinguishable from *T. prolifera*. Groves considered *T. fimbriata* to be a slender form of *T. prolifera*. I agree that they are not separable, a view I have already expressed in my "Notes on Charophytes from British Columbia" (Proc. Linn. Soc. 162 pt. 2, 149 (1952)).

5. TOLYPELLA CALIFORNICA Br. Lit. Allen, Bull. Torrey Bot. Club, 114

(1883). Illustr. Fragmente, pl. 3, figs 84–87: Allen l. c. pl. 40. Stem medium, c. 600 μ in diameter. Sterile whorls of 12–15 usually once-divided branchlets; laterals 4, consisting of 4–7 cells (some of the sterile branchlets are simple and shorter), which get progressively shorter and narrower towards the bluntly conical apex. Fertile whorls densely crowded, branchlets generally twice-divided with usually 3 4–6-celled simple laterals at the first node and the same at the second node, the central ray continuing to a much greater length. Oogonia and antheridia at branchlet nodes and in the base of the stem-whorl. Oogonia usually 2 together with an antheridium; coronula persistent. Oospore brown, 285–335 μ long, c. 320 μ broad, showing 8–9 striae which are not prominent. Membrane plain with perhaps very faint granules. Antheridium rather long-stalked, 240–265 μ in diameter.

Distr. California, in flowing stream, 1865, leg. H. Bolander and another specimen from California, prob. leg. Bolander. A record from Douglas Co., Washington 1893, leg. J. H. Sandberg and J. B. Leiberg No. 336 is open to some doubt being a much larger plant with the rays not tapering as in the *Fragmente* illustration but terminating in 1–3 abruptly smaller cells.

A small plant, c. 10 cm. tall, much branched and hence bushy in appearance. The fertile whorls are on longer stems and so do not form such dense masses as some species though the little heads themselves are crowded. No lime-incrustation.

Braun describes it as somewhat similar to the European *T. nidifica* from which it is clearly distinguishable by the ultimate cells of the rays being conical.

Allen gives the length of the oospore as considerably smaller than in Braun's original description (380 μ long and 320 μ broad). My own figures come smaller still at c. 325 μ long and c. 275 μ broad.

6. TOLYPELLA STIPITATA Allen in Bull. Torrey Bot. Club 10: 114 (1883). Illustr. Allen l. c. pl. 41. Stem medium size. Sterile whorls of c. 8 branchlets having 1–2 nodes; laterals usually 3, simple, long, but with a longer central ray, 3–4-celled; end-cell long-conical with acute apex. Fertile whorls in rather loose compound heads, whorls giving rise to 4 branchlets of 1–2 nodes and to usually 2 (occ. 3) shoots on appreciably long peduncles, laterals 3, simple, 3-celled. The peduncles being longer than usual cause the heads to appear less compact than in most species. Oogonia and antheridia stalked, at the nodes and crowded in the base of the whorl. Oogonia aggregate, coronula presistent, with short squat cells. Oospore light chestnut brown, c. 330 μ long and 270 μ broad with 7–8 slightly prominent striae. Antheridium 275–300 μ in diameter. I found the plant heavily lime-incrusted.

Distr. Mt. Carbon, Elk Range, Western Colorado, 1881, leg. T. S. Brandegee. The only record.

A small plant, c. 10–15 cm. tall (fide Allen, though the specimen I saw did not look more than 7 cm.) In his description Allen placed *T. stipitata* as "intermediate between *T. californica* and *T. intricata*. From the former it differs in the fewer segments of the terminals and from the latter in the simple rays and smaller sporangia and antheridia."

The exceptionally long lateral rays tend to give the plant somewhat the appearance of a *Nitella*. Allen's plate is excellent though I found the central terminal ray of the branchlets to be conspicuously longer than the laterals instead of more or less equal as depicted.

7. TOLYPELLA INTERTEXTA Allen in Bull. Torrey Bot. Club 10: 115

(1883). Illustr. Allen l. c. pl. 42. Stem stout. Sterile whorls of 8 simple or once-divided branchlets; laterals 3, unequal; the central ray much longer than the others, consisting of 4 cells which get progressively shorter with an abrupt end, apical cell a short stout mucro. Fertile whorls in large dense heads of branchlets with 2 (rarely 3) nodes; laterals divided, with 2–3 secondary laterals which are usually 4-celled. Oogonia and antheridia at the base of the whorl and at the branchlet and lateral ray nodes. Oogonia aggregate, coronula elongated, upper tier considerably longer than the lower, subpersistent. Oospore brown, oval, 450–475 μ long and c. 350 μ broad, showing 10 rather prominent sharp striae. Membrane plain, fide groves. Antheridium on a short stalk, 320–350 μ in diameter.

Distr. Cayuga Lake, New York, 1882, leg. T. F. Allen, 1900, leg. G. F. Atkinson 5320, 1932, leg. W. C. Muenscher and U. M. Lefler 165: Lake Seneca, N. Y., 1883, leg. T. F. Allen (Ch. Am. ex. 37) and other N. Y. localities, also Vermont and Ohio: Canada leg. Cary fide T. F. A.

A large plant 40–50 cm. tall. Usually lime-incrusted. Allen considered *T. intertexta* allied to *T. intricata* from which he distinguished it by its large robust habit, the rather larger oospores, its oblique coronula and its fruiting in the autumn (as opposed to *T. intricata* which in Europe fruits mainly in May.) The abrupt termination of the ultimate ray in *T. intertexta* is also quite different from the tapering ray in *T. intricata.*

8. TOLYPELLA INTRICATA Leonh. Lit. Fragmente, 99: Migula, Die Characeen 214: Groves in Journ. Bot. 18: 163 (1880): Groves and Bullock-Webster, Br. Char. 1: 130. Illustr. Migula l. c. figs. 61–63: Groves l. c. pl. 209, fig. 13: Groves and B.-W., l. c. pl. 17: Kützing, Tab. Phyc. 7: pl. 36. Stem moderately stout, usually much branched. Lower whorls (sterile and lower fertile), distant, consisting of 6–7 large divided branchlets, with 1–2 nodes, and about as many small simple accessory branchlets. Upper fertile whorls forming large rather dense heads with shorter branchlets having usually 2 nodes. At the first branchlet node are produced 3–4 widely divergent divided laterals and one central ray which is usually again divided with 3–4 simple laterals and a central elongated ray. Ultimate rays 5–6-celled, the cells diminishing in length and breadth so that the ray tapers to the apex: end cell bluntly conical. Oogonia stalked or sessile, 2–4 at each node and frequently also in large numbers at the base of the whorl: coronula persistent, cells of each tier of about equal size. Oospore light golden yellow, c. 350 μ long and 275 μ broad, showing c. 10 very thin prominent often winged striae. Membrane very finely granulate. Antheridium stalked or sessile, at the nodes and base of the branchlets, c. 400 μ in diameter.

Distr. Canada: vide Allen who states that he received one specimen, a typical form, but gives no further particulars. I did not find any specimen in the New York herbarium.

A rather large robust plant as tall as 40 cm. Allen mentions that it grows in mossy bunches and Migula says it is tufted and much branched.

In Nordstedt's key to the *Fragmente T. intricata* is distinguished from *T. californica* by the laterals (*radii secundarii*) being often divided whereas in *T. californica* the laterals are simple.

Allen's original Synopsis (The Characeae of America, 1888) is mainly a translation of Nordstedt's key except for a few alterations by Nordstedt and Allen himself, the synopsis of Tolypella being rewritten by the latter.

One alteration is Allen's addition of the word "fertile" to Nordstedt's subsection "*Radii secundarii saepe divisi*" and in his description of *T. intricata* Allen speaks of the lateral rays at the first node of the fertile branchlet being divided. Migula also (*Die Characeen,* 217) distinctly says the same.

When however I was studying this point in connection with my "British Stoneworts (Charophyta)" (1950), I was surprised to find that Groves and Bullock-Webster in *British Charophyta* seemed to describe these fertile laterals as simple and I could find no illustration to confirm the fact that they were divided.

I examined what little suitable material I had of this rather rare plant and came to the conclusion that though these laterals were sometimes divided they were much more often simple. (Incidentally I inadvertently mentioned in British Stoneworts that the *Fragmente* also stated that the laterals were divided; I probably overlooked at the time Allen's insertion of the word "fertile" to Nordstedt's key.)

Consequently the division of the fertile laterals at the first node may not be a very reliable key character for *T. intricata* but having no means of checking this in American specimens I have accepted Allen's description.

GODALMING
SURREY, ENGLAND

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A BOLIVIAN ELAPHOGLOSSUM OF UNIQUE LEAF STRUCTURE

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Elaphoglossum is a large fern genus of "far over 400 species, in all warm countries, most numerous in the Andes" (Copeland 1947, p. 119). Its relationships have been interpreted variously in current revisions of fern classification (Holttum 1949, Ching 1940). Although the systematic position of this genus of ferns is thus not settled, the investigations of features such as those of the gametophyte (Stokey 1951) and the anatomy of the sporophyte (Bell 1950, 1951) may be expected to provide new evidence of relationship. Recently the peculiar leaf structures of two apparently closely related genera, *Rhipidopteris* and *Microstaphyla*, were discussed by the writer (1952), and it was suggested that the leaves of these genera, which are dichotomously and pinnately divided respectively, were derived from the basic type found in the genus *Elaphoglossum*. In the latter genus over-all leaf architecture is remarkably uniform, being characterized by blades which are simple, and entire or nearly so. Although *Elaphoglossum* displays much diversification in other features, the modifications of basic leaf form are expressed among the different species largely in over-all size, blade outline, and the relative development of the petiole or stipe. The only exceptional leaves are occasional forked or crested specimens.

In the course of a study of dichotomous types of leaves in ferns at the Gray Herbarium, attention was drawn to an unidentified plant left by the late Mr. C. A. Weatherby. This specimen, which is complete and includes a rhizome, conforms with the genus *Elaphoglossum* in all respects except in the form of its leaf-blade, which is apparently entirely unique. The blade architecture is of a peculiar pedately-lobed type, suggesting somewhat leaf outlines seen in certain Araceae (e.g., *Sauromatum guttatum*, Posthumus 1929, fig. 26). In the living state the lateral lobes of the leaves of this fern were probably borne in a more or less horizontal plane. The blade is constructed in the following manner: At the base of the central lobe (which by itself resembles a common type of blade in *Elaphoglossum*) one large lateral lobe arises on each side. A short distance from the base of each primary lobe arises a single secondary lobe; from the base of this is produced a tertiary lobe, and the last produces a quaternary lobe (fig. 2). Basiscopic development of leaves of certain fern genera (e.g., *Doryopteris*, *Hemionitis*, and spp. of *Pteris*) is well-known, but very few show such an extreme development of the lower part of the leaf.

That the leaves of this specimen represent abnormalities suggests itself as a possibility. But this seems unlikely: Altogether there are seven fronds

—three fertile ones and four sterile—and each has exactly the same structure. One of the leaves lacks the system of lobes on one side of the blade, but a point of injury is evident where the vein leading to the missing main lateral lobe can be seen. The condition thus appears to be too uniform and regular to be considered teratological.[1] No other *Elaphoglossum* has been reported with such leaves.

The fern was collected "at one of the stop stations made while traveling from Chimoré to Cochabamba," Bolivia, at an altitude of 2000 m. by Dr. Martin Cárdenas (letter, November 23, 1952). Unfortunately the general locality where the fern was taken is not likely to be revisited in the near future, and the exact spot in which it was found is not known at the present time. It would be desirable, however, to attempt to find further specimens of this unusual species, and especially to find the early leaf stages which show at what stage in the progression of leaves the unique foliar organization arises.

To Dr. Cárdenas I am indebted for providing information and material for this study; and to Mr. Conrad V. Morton I am grateful for providing the latin diagnosis and for suggestions.

Elaphoglossum cardenasii Wagner, sp. nov. Planta epiphytica; folia spissa, stipitibus elongatis, laminis pedato-partitis, lobo mediano ligulato, acriter acuminato, lobis basalibus unijugis, 4-plo basiscopice divisis, lobis omnibus simplicibus, ligulatis, acuminatis, integris vel apicem versus undulato-crenulatis, subtus paleaceis, paleis costalibus majoribus patentibus, atrobrunneis, subulatis, integris, paleis superficialibus numerosis, minutis, rotundis, fimbriatis; folia fertilia sterilia superantia, subsimilia sed multo minora, subtus ubique sporangiifera.

Epiphytic fern of moderate size. Rhizome horizontal, 1 cm. in diameter and at least 3 cm. long at maturity, dictyostelic, dorsiventral, roots produced below and leaves above. Roots approximately 1 mm. apart at their bases, "woody," dark-brown, 0.5 mm. thick and at least 6.5 mm. in length, numbering about 40 along 1.5 cm. of the length of the rhizome. Root hairs dark-brown, sparse and inconspicuous, 1.0–1.5 mm. long. Rhizome paleae (fig. 1) ovate-acuminate, attached basally, 2–3 mm. long, dull-brown. Stipe paleae similar, but smaller, 1–2 mm. long, overlapping in the lower third of the stipe but becoming more remote distally, 3–5 mm. apart. Leaves crowded on the rhizome. Sterile leaves 33–39 cm. long, their stipes 20–23 cm. long and 1.5–2.0 mm. in diameter, sulcate above, straw-brown except in white blotches where the scales have fallen. Blades pedately lobed (fig. 2), 12–22 cm. in over-all length, 14–20 cm. broad (in the dried specimens), comprising a large acuminate-tipped central "lobe," 13–16 cm. long, 12–15 mm. wide, and a three times basally divided lateral lobe at the bottom of the blade on each side. Main lateral segments 9–12 cm. long, 8–12 mm.

[1] Since the study of this species was originally carried out, Dr. Cárdenas kindly sent a tracing of the fronds of an additional specimen in his private herbarium. The two fertile and three sterile leaves of his specimen all show the same outline as those I have examined and described above, bringing to 12 the total of known leaves of this species.

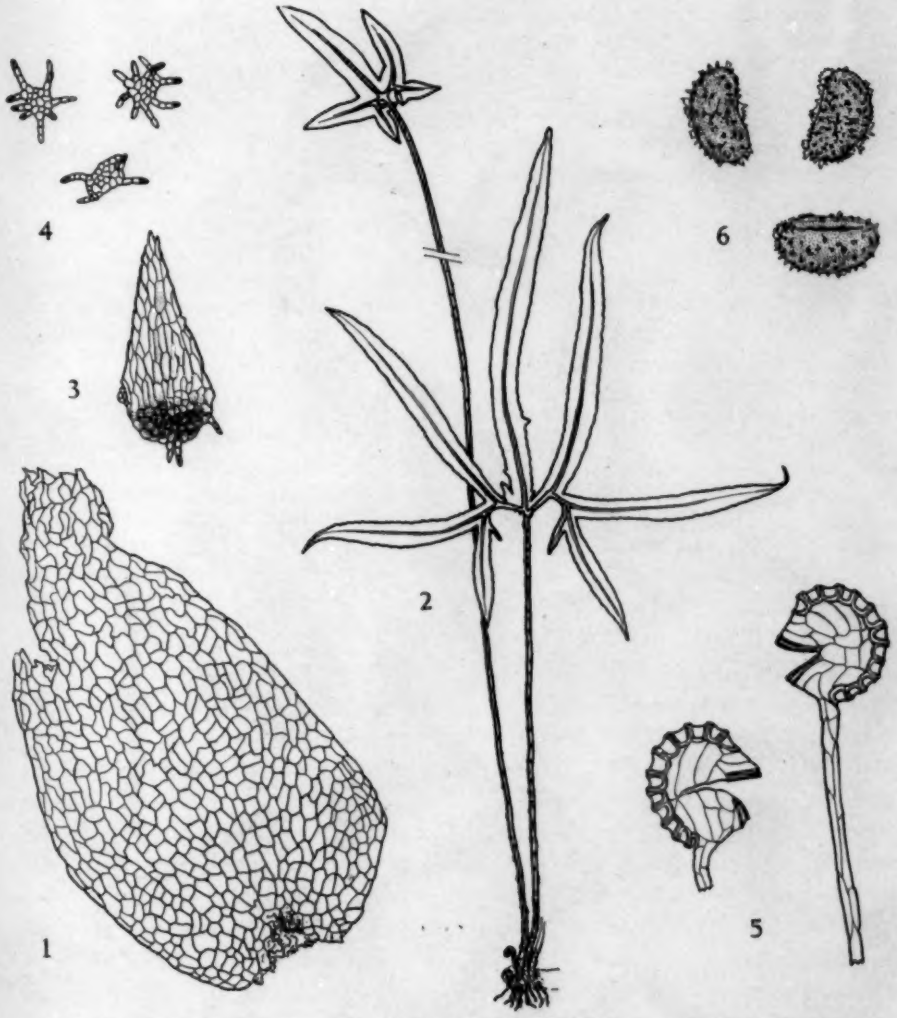

FIG. 1. Scale from the base of the stipe of *Elaphoglossum cardenasii* ×30. FIG. 2. Habit of plant, ×¼. FIG. 3. Scale from the costa on the abaxial leaf surface, ×30. FIG. 4. Squamules from the abaxial laminar surface, ×30. FIG. 5. Sporangia, ×60. FIG. 6. Spores, ×300.

broad, producing on the lower sides at 1.0–1.2 cm. from their bases secondary segments 6–9 cm. long, 8–11 mm. wide; secondary segments bearing similar but smaller tertiary lobes 0.5–1.0 cm. from their bases, the tertiary lobes 3–5 cm. long, 0.5–0.8 mm. wide; tertiary lobes bearing small quaternary lobes, these 1–3 cm. long and 2–5 mm. wide. Margins of segments slightly undulate to shallowly crenate. Lamina chartaceous, dull-green. Venation free, the veinlets simple or once-forked, maintaining an average angle of 40°–60° with the costa, and an interveinal distance of 1–2 mm.

FIG. 7. *Elaphoglossum cardenasii* Wagner, sp. nov. Type Specimen. GRAY HERBARIUM.

Vein tips abruptly expanded, terminating 0.5 mm. from the margin. Trichomes of the leaf blade of three types—the costal paleae of the abaxial side (fig. 3) bullate in the lower fourth or third, triangular, 0.5–1.0 mm. long, dark-brown, borne 1–3 mm. apart along each side of the costa; paleae of the abaxial laminar surface tiny squamules, 0.1–1.3 mm. across, with 3–10 processes of 2–5 cells each (fig. 4), distributed 0.6–1.0 mm. apart over the lower epidermis; paleae of the adaxial laminar surface triangular, 0.2–0.5 mm. long, 2–3 mm. apart. Fertile frond similar to the sterile in organization, but with a small blade (fig. 2), only 4–8 cm. long, 5–10 cm. broad, and a very long stipe, 39–43 cm. in length. Upper surface of fertile blade glabrous. Soral arrangement acrostichoid, the sporangia densely covering the lower surface. Sporangial capsules 220–280 μ long, 200–260 μ broad at their widest point, the annulus vertical, comprising 10–13 thick-walled cells, and separated by 2–3 thin-walled cells from the stomium. Sporangial stalks 400–700 μ long, composed of 2 rows of 3–5 cells each except for the 3-rowed region just below the capsule (fig. 5). Spores (removed from dried specimen and mounted in aqueous sodium hydroxide solution for study) pale-green, "bean-shaped," 40–45 μ long and 21–24 μ broad (dimensions of exospore), with delicate hyaline perisporial crests and spines 1–4 μ tall, the proximal scar approximately 20 μ long and conspicuous (fig. 6).

TYPE. "Way from Cochabamba to Chimoré, about Km. 120. Province of Chapare, Department of Cochabamba, Bolivia, 2,000 m. Epiphytic herb growing on tree ferns in a damp high mountain forest. III, 1940. *M. Cárdenas 795.*" GRAY HERBARIUM.

Relationships. Comparison of specimens of this fern was made at the Gray Herbarium and the Herbarium of the Chicago Natural History Museum, but no closely similar species were found. The forms of the scales of the laminar surfaces, the angle and spacing of the veins, and other features of this fern are individually closely simulated by the corresponding features of other species. For example, the scales of *Elaphoglossum guatemalense* are rather similar to those of *E. cardenasii*. *Elaphoglossum villosum* has a similar vein pattern, and the outline of the blade resembles that of the central segment of the present species, but the scales are different. *Elaphoglossum unduavense* suggests a possible relative, especially in its scales, but the venation is close and the lamina is thicker-textured, with somewhat rolled margins. Also the leaf of *E. unduavense* is only one-half as tall as that of *E. cardenasii*, and the stipe is dark basally.

The question might be raised whether the striking foliar structure of *Elaphoglossum cardenasii* would not justify its separation as a distinct genus of ferns. However, leaf structure by itself, in ferns, does not appear to be dependable for generic separation. Radically modified leaves appear in numerous fern genera, suggesting that foliar organs in ferns are capable of considerable "evolutionary plasticity." The change from uniform leaves to dimorphism of fertile and sterile leaves, for example, has apparently occurred in many different lines, and frequently has taken place within the

confines of one genus. All species of *Elaphoglossum* possess dimorphic leaves, but in some the fertile leaf is more differentiated from the sterile than in others. Evolution from free to reticulate venation occurred in many lines of fern evolution. The situation of *Asplenium finlaysonianum* and several other species of *Asplenium* with reticulate veins in a genus with otherwise free veins is similar to that of at least two species of reticulate-veined Elaphoglossums to be mentioned below. Examples of evolution from the divided-blade state to the simple blade are likewise to be found in a number of lines of fern evolution (e.g., *Cyathea sinuata* in the Cyatheaceae). Dickason (1946) has discussed a number of situations of this nature. Even more radical modifications are shown by the crested blades of certain fern species (e.g., *Ophioglossum palmatum* in the Ophioglossaceae, and *Hecistopteris pumila* in the Vittariaceae), and the midribless blades of others (*Lindsaea reniformis* in the Pteridaceae, and others discussed by Wagner 1952). Because of this apparent "evolutionary plasticity" of foliar structures in the ferns, anatomical and cytological characters appear to be more dependable and conservative.

In *Elaphoglossum* and what appear to be its close relatives no less than five foliar types evidently have arisen from the simple, and presumably ancestral, blade with pinnate, free veins. These are as follows: 1. Blade simple, but venation reticulate (*E. reticulatum* and *E. crinitum*); 2. Blade pinnately-lobed (*Microstaphyla* spp.); 3. Ternately lobed, or dissected (*Rhipidopteris tripartita*); 4. Dichotomously lobed or dissected (*R. flabellata, R. peltata,* and *R. foeniculaceae*); and 5. Blade pedately-lobed (*Elaphoglossum cardenasii*). Types 1 and 5 were probably derived independently of each other from the typical condition of *Elaphoglossum,* but there is a possibility that types 2, 3, and 4 represent a sequence.

In view of numerous examples of radical alterations of foliar structure in lines of fern evolution, it may be suggested that other, more critical characters should be adopted in framing a generic concept in the *Elaphoglossum* group. Numerous data should be used, however, for such an analysis. The present composition of the genus *Microstaphyla* has already been questioned (Wagner 1952), and possibly, since the generic recognition of *Rhipidopteris* and *Microstaphyla* is founded upon their respective leaf forms, these two genera will be shown to be more closely related to certain species groups in *Elaphoglossum* (e.g., the group of *Elaphoglossum squamatum,* as suggested by Christ 1899) than those groups are to other groups in that genus as currently interpreted.

SUMMARY

1. The fern genus *Elaphoglossum* contains several hundred species, all of which have simple leaf blades. Discussed and described here is an excep-

tional Bolivian species, *E. cardenasii* sp. nov., the leaves of which are pedately-lobed.

2. Since leaf form appears to be capable of great plasticity from an evolutionary standpoint, the unique leaf structure of this species is not regarded as sufficient for generic distinction from *Elaphoglossum*.

3. This new fern adds another radical form to the types of modified leaves believed to have been derived from the basic *Elaphoglossum* leaf, which has a simple blade and free, pinnately arranged veins.

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A FURTHER STUDY OF THE CHROMOSOME MORPHOLOGY OF SOME SPECIES OF TRILLIUM

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A study was made recently of the chromosome morphology of six of the sessile species of *Trillium* (Bailey 1951) in an attempt to determine whether there existed any variations between the chromosome morphology of the six species, and, if any variations did occur, whether they were sufficient to separate species or make groupings of species. Bailey (1951) concluded from his study that there were sufficient differences between the chromosome morphology of the species studied to possibly be of some significance in the separation or grouping of certain species. This study is a further attempt to determine whether any significant variations do occur between species. The criteria used were those which had been employed previously, that is, the total length of the normal chromosome complement, the total length of individual chromosomes, and the relative length of the chromosome arms.

Materials and Methods. Ten different species of *Trillium* were used in this study. Rhizomes of the several species were collected from various parts of the country and identification made by those individuals furnishing the rhizomes. Where possible herbarium specimens were furnished and identifications checked from these. *Trillium Hugeri* Small was collected near Chattanooga, Tennessee by Miss Eleanor McGillard; *Trillium ludovicianum* Harbison by Dr. Erdman West near Gainesville, Florida; *Trillium Vaseyi* Harbison and *Trillium Catesbaei* Ell. from Highlands, North Carolina by Mr. Henry Wright. Rhizomes of *Trillium grandiflorum* (Michx.). Salisb. were available from several different regions. These were furnished by Dr. Paul W. Patterson of Hollins College, Dr. H. V. Truman of Denison University, Dr. A. B. Massey of Virginia Polytechnic Institute, Dr. John L. Morrison of The State University of New York College of Forestry, Rev. M. G. Duman of St. Vincent College, and Mr. Henry Wright of Highlands, North Carolina. Rhizomes of *Trillium flexipes* Raf. were furnished by Dr. R. F. Thorne of The University of Iowa and Dr. Ray C. Friesner of Butler University. Rhizomes of *Trillium cernuum* L. were collected near Alexander City, Alabama and others were furnished by Dr. Arthur L. Cohen of Oglethorpe University. Rhizomes of *Trillium nivale* Riddell were furnished by Dr. Frank T. McFarland of The University of Kentucky, Dr. T. G. Yunker of DePauw University, Dr. A. T. Guard of Purdue University, and Dr. R. F. Thorne of The University of Iowa. Rhizomes of *Trillium undulatum* Willd. were furnished by Dr. William G. Houk of St. Lawrence University, Dr. A. B. Massey of Virginia Polytechnic Institute, Dr. John L. Morri-

TABLE 1. *Comparative data on chromosome morphology of some species of Trillium.*

Species	Chromosome														Total
	A			B			C			D			E		
	L.	S.	T.	L.	S.	T.	L.	S.	T.	L.	S.	T.	L.	S.	T.	
1. *T. Hugeri* Small.	12.5	1.6	14.1	13.3	6.1	19.4	7.6	6.3	13.9	10.4	7.0	17.4	13.3	13.3	26.6	182.8
2. *T. ludovicianum* Harbison.	16.0	1.6	17.6	16.1	7.1	23.2	8.7	5.9	14.6	12.5	9.0	21.5	15.2	14.0	29.2	212.2
3. *T. Vaseyi* Harbison.	15.0	1.6	16.6	14.8	5.4	20.2	9.6	6.6	16.2	12.2	7.5	19.7	15.3	13.7	29.0	203.4
4. *T. Catesbaei* Ell.	13.3	1.6	14.9	15.1	7.1	22.2	11.1	9.1	20.2	13.1	8.8	21.9	12.5	11.6	24.1	206.6
5. *T. grandiflorum* (Michx.) Salisb.	15.1	1.6	16.7	15.1	5.0	20.1	9.0	5.6	14.6	12.3	8.3	20.6	14.6	13.3	27.9	199.8
6. *T. flexipes* Raf.	14.5	1.6	16.1	13.8	3.5	17.3	9.7	6.6	16.3	12.3	8.1	20.4	14.8	13.3	28.1	196.4
7. *T. cernuum* L.	15.9	1.6	17.5	15.4	6.8	22.2	11.6	9.5	21.1	14.9	9.7	24.6	14.1	12.0	26.1	223.0
8. *T. nivale* Riddell.	16.1	1.6	17.7	12.9	3.3	16.2	7.5	4.7	12.2	10.0	7.2	17.1	13.6	11.3	24.9	176.4
9. *T. undulatum* Willd.	12.5	1.6	14.1	11.9	3.3	18.5	8.3	5.2	13.3	11.2	7.0	18.2	12.1	10.8	22.9	174.4
10. *T. erectum* L.	14.8	1.6	16.4	14.4	5.0	19.4	9.0	6.2	15.2	11.9	8.1	20.0	14.9	13.3	28.2	198.4

L.—Long Arm; S.—Short Arm; T.—Total length.

A
B
C
D
E
2
3
4
5
6
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9
10

son of The State University of New York College of Forestry, Rev. M. G. Duman of St. Vincent College, and Mr. Henry Wright of Highlands, North Carolina. Rhizomes of *Trillium erectum* L. were furnished by Mr. Henry Wright of Highlands, North Carolina, Dr. John L. Morrison of The State University of New York College of Forestry, Dr. George R. Cooper of The University of Maine, Rev. M. G. Duman of St. Vincent College, Dr. William G. Houk of St. Lawrence, and Dr. C. L. Wilson of Dartmouth College.

All rhizomes used in this study were potted in peat moss and fresh growing root tips were used as a source of material. All material for study was prepared using the Feulgen technique together with a squash method (Woodard 1948). Measurements were made using an ocular micrometer.

Observations and discussion. The morphology of the normal chromosome set of *T. Hugeri, T. ludovicianum, T. Vaseyi, T. Catesbaei, T. grandiflorum, T. flexipes, T. cernuum, T. nivale, T. undulatum,* and *T. erectum* were carefully studied. Measurements were made on approximately 100 metaphase chromosomes of each type (A, B, C, D and E) for each of the ten species included in this study. Results of these measurements are shown in table 1. The total length of the normal chromosome set as well as the length of individual chromosomes and the length of the chromosome arms are shown for each species.

Diagrams showing the comparative length of individual chromosomes for each species and the position of the primary constriction are given in figures 1 to 10. The position of the primary constriction is approximately the same in each type chromosome for all species studied, that is, the primary constriction for chromosome A is sub-terminal, that of B, C and D is sub-median, and that of chromosome E is only slightly sub-median. The position of the primary constriction in general is no different from those species included in the previous study (Bailey 1951).

The total length of the normal diploid chromosome set of *T. Hugeri* was found to be 182.8 microns, *T. nivale* 176.4 microns, and *T. undulatum* 174.4 microns. These measurements are fairly close, none of them differing by more than 8.4 microns. These measurements approach very closely the length given for *T. sessile, T. recurvatum,* and *T. stamineum* in the previous study (Bailey 1951). The total length of *T. sessile* was given as 177.9 microns, *T.*

FIGS. 1–10. Diagrammatic analysis of chromosome morphology of several species of *Trillium*. FIG. 1. Normal chromosome set of *T. Hugeri*. FIG. 2. Normal chromosome set of T. ludovicianum Harbison. FIG. 3. Normal chromosome set of *T. Vaseyi*. FIG. 4. Normal chromosome set of *T. Catesbaei*. FIG. 5. Normal chromosome set of *T. grandiflorum* (Michx). FIG. 6. Normal chromosome set of *T. flexipes*. FIG. 7. Normal chromosome set of *T. cernuum*. FIG. 8. Normal chromosome set of *T. nivale* Riddell. FIG. 9. Normal chromosome set of *T. undulatum* Willd. FIG. 10. Normal chromosome set of *T. erectum*.

All figures are drawn to scale at an approximate magnification of ×1770 after reduction.

recurvatum 180.1 microns, and *T. stamineum* 179.9 microns. If the above six species are considered as a group their range in total length would be from 174.4 microns in *T. undulatum* to 182.8 microns in *T. Hugeri*. This would give a maximum difference of 8.4 microns between the total lengths of the six species. *T. vaseyi* has a total length of 203.4 microns, *T. Catesbaei* 206.6 microns, *T. grandiflorum* 199.8 microns, *T. flexipes* 196.4 microns, and *T. erectum* 198.4 microns. These measurements are fairly close with a maximum difference of 10.2 microns, the range being from 196.4 microns in *T. flexipes* to 206.6 microns in *T. Catesbaei*. *T. ludovicianum* shows a total length of 212.2 microns and *T. cernuum* a total length of 223.0 microns. If the ten species included in this study along with the six species of the previous study (Bailey 1951) are compared, the range in total length would be from 166.4 microns in *T. decumbens* to 223.0 microns in *T. cernuum*.

If the ten species included in this study and the six species of the previous study (Bailey 1951) were grouped on the basis of the total length of their chromosome complements it would be possible to make four or five groupings. *T. decumbens* would probably be in a group to itself since it differs by approximately 10 microns from the next closest group. *T. undulatum, T. nivale, T. Hugeri, T. sessile, T. recurvatum*, and *T. stamineum* could possibly be considered together since the maximum difference in total length is 8.4 microns. *T. lancifolium* with a total length of 192.9 microns and *T. luteum* with a total length of 193.6 microns stand in a group to themselves. *T. erectum, T. flexipes, T. grandiflorum, T. Catesbaei*, and *T. Vaseyi* compose a group which has a maximum difference of 10.2 microns. *T. ludovicianum* differs slightly from the last mentioned group whereas *T. cernuum* definitely falls in a group to itself at the upper range of total lengths. Perhaps it would be difficult to establish these as definite groupings since the range within groups is quite large and the difference between groups is not too great. However, it does seem that certain species of *Trillium* could definitely be separated on the basis of the total length of their chromosome complements.

Total length of individual chromosomes may offer some help in the separation of certain species of *Trillium*. The total length of chromosome A ranges from 14.1 microns in *T. Hugeri* and *T. undulatum* to 17.7 microns in *T. nivale*. These differences in total length of chromosome A do not seem great enough to be of any significance but could possibly be used along with other factors for species separation if the species in question were at opposite ends of the range.

Chromosome B in *T. nivale* shows a total length of 16.2 microns and in *T. ludovicianum* the length is 23.2 microns, 7 microns longer than in *T. nivale*. The other species show a fairly uniform range between these two, some falling near the lower limit and some near the upper limit.

The total length of chromosome C ranges from 12.2 microns in *T. nivale* to 21.1 microns in *T. cernuum*. This gives a difference of 8.9 microns between the length of chromosome C in the two species mentioned, a difference great enough to probably of considerable significance in the separation of the two species.

Chromosome D ranges in total length from 17.1 microns in *T. nivale* to 24.6 microns in *T. cernuum*. This is a difference of 7.5 microns and would probably be great enough to indicate a separation between the two species. *T. decumbens* shows a total length of 16.6 microns for chromosome B (Bailey 1951). This would make a difference of 8.0 microns between chromosome B in *T. decumbens* and *T. cernuum*.

Chromosome E probably shows less variation in total length than either chromosome B, C, or D. The maximum difference in total length of chromosome E is 6.3 microns. The measurements range from 22.9 microns in *T. undulatum* to 29.2 microns in *T. ludovicianum*.

The above comparisons as to length of individual chromosomes may be seen in figures 1 to 10.

Table 2 shows the ratios of the chromosome arms, that is the ratio of the

TABLE 2. *Long-arm, short-arm, ratios in chromosomes of some species of Trillium.*

Species	Chromosome				
	A	B	C	D	E
1. *T. Hugeri* Small.	12.8:100	45.9:100	82.9:100	67.3:100	100:100
2. *T. ludovianum* Harbison.	10.0:100	44.1:100	67.1:100	72.0:100	92.1:100
3. *T. Vaseyi* Harbison.	10.7:100	36.5:100	68.7:100	61.5:100	89.5:100
4. *T. Catesbaei* Ell.	12.0:100	47.0:100	82.0:100	67.2:100	92.8:100
5. *T. grandiflorum* (Michx.) Salisb.	10.6:100	33.1:100	60.2:100	67.5:100	91.1:100
6. *T. flexipes* Raf.	11.0:100	25.4:100	65.9:100	65.0:100	89.9:100
7. *T. cernuum* L.	10.1:100	44.2:100	81.9:100	65.1:100	85.1:100
8. *T. nivale* Riddell.	9.9:100	25.6:100	62.1:100	72.0:100	83.1:100
9. *T. undulatum* Willd.	12.8:100	27.7:100	62.6:100	62.0:100	89.3:100
10. *T. erectum* L.	10.8:100	34.7:100	68.6:100	68.1:100	88.5:100

length of the short arm to the length of the long arm for the chromosomes of each species studied. A careful analysis of these arm length ratios reveals one or two significant facts as to species separation on the basis of chromosome morphology. The arm length ratios in chromosome A range from 9.9:100 in *T. nivale* to 12.8:100 in *T. Hugeri* and *T. undulatum*. These differences would probably not be significant. The arm length ratios of the previous study (Bailey 1951) show about this same range.

Chromosome B has an arm length ratio ranging from 25.4:100 in *T. flexipes* to 47.0:100 in *T. Catesbaei*. Four species of the previous study (Bailey 1951) show an arm length ratio which approaches the range given

above. These four species include *T. decumbens* (42.8:100), *T. luteum* (36.0:100), *T. sessile* (40.6:100), and *T. recurvatum* (43.9:100). *T. lancifolium* (62.2:100) and *T. stamineum* (68.8:100) show a somewhat higher ratio for chromosome B.

The arm length ratio of chromosome C in *T. Hugeri* is 82.9:100, *T. Catesbaei* 82.0:100, and *T. cernuum* 81.9:100. These ratios are very close and are somewhat higher than in the other seven species of this study. Their ratios range from 60.2:100 in *T. grandiflorum* to 68.7:100 in *T. Vaseyi*. The previous study (Bailey 1951) shows the arm length ratio of chromosome C in *T. lancifolium* (80.0:100) to be very close to the group composed of *T. Hugeri*, *T. Catesbaei*, and *T. cernuum*, *T. decumbens* (70.0:100), *T. luteum* Muhl.) (65.5:100), and *T. sessile* (69.1:100) approach more closely the group composed of *T. ludovicianum*, *T. Vasseyi*, *T. flexipes*, *T. Nivale*, *T. undulatum*, *T. grandiflorum*, and *T. erectum* whereas *T. recurvatum* (75.2:100) and *T. stamineum* (74.3:100) fall between the two groups.

Chromosome D shows an arm length ratio ranging from 61.5:100 in *T. Vaseyi* to 72.0:100 in *T. nivale* and *T. ludovicianum*. In the previous study (Bailey 1951) *T. decumbens* (67.4:100), *T. lancifolium* (77.3:100), *T. sessile* (67.5:100), *T. recurvatum* (67.0:100), and *T. stamineum* (61.0:100) show ratios close to that found in *T. Hugeri*. *T. luteum* shows a ratio of 52.6:100 for chromosome D. This indicates that the range in the arm length ratios of chromosome D is not great enough to be very significant in the separation of species.

Chromosome E shows a range of from 83.1:100 in *T. nivale* to 100:100 in *T. Hugeri* with most of the species having a ratio of around 90:100. Species included in the previous study (Bailey 1951) show about this same range. The difference in arm length ratios for chromosome E of the various species would probably not be of great significance.

In connection with the idea of arm length ratios or position of the primary constriction, *T. undulatum* shows a very outstanding peculiarity. The primary constriction of chromosome B acts as a region of differential reactivity which is usually associated with chromosomes which have been exposed to cold treatment. This constriction appears as a non-staining segment of reduced diameter. This segment was found to be 3.3 microns in length. The total length of the entire chromosome is given as 18.5 microns in table 1. The length of the long arm is given as 11.9 microns and the short arm as 3.3 microns. Actually the length of the long arm plus the length of the short arm would give a total length of only 15.6 microns, but when the length of the primary constriction is added the total length is 18.5 microns. This is the only instance in the sixteen species included in this and the previous study (Bailey 1951) where such a segment has shown up in normal material.

SUMMARY

1. Certain species of *Trillium* may be separated from each other on the basis of the total length of their chromosome complements.

2. The arrangement of all species of *Trillium* into definite groups on the basis of the total length of their chromosome complements would be difficult since there are species which have total lengths that fall between what could be established as definite groups.

3. Total length of individual chromosomes may offer some help in the separation of certain species of *Trillium*.

4. Arm length ratios may be of help only in the separation of certain species of *Trillium*.

5. The primary constriction in chromosome B of *T. undulatum* Willd. which acts similarly to the differentially reactive segments in cold treated material would be a significant characteristic of the chromosome morphology of that species.

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THE SPIHONOCLADALES

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In recent years there has been some discussion about the validity or otherwise of the order Siphonocladales (Feldmann 1938, Fritsch 1947, Egerod 1952). Much of this has been summarized in the last of these contributions. The only justification the present writer has for entering this discussion arises from information obtained during a revision of the New Zealand marine Chlorophyceae (Chapman in press, Chapman 1952, Chapman 1953). In this revision a new species of *Microdictyon* came to light (Dellow 1950) and it was also necessary to study local species of *Cladophoropsis*.

The present writer agrees with Feldmann and Egerod in recognizing the order Siphonocladales, and is unable to subscribe to Fritsch's view that the Siphonocladaceae, Valoniaceae, Dasycladaceae, Boodleaceae and Anadyomenaceae should be classed as septate Siphonales. He also agrees with Feldmann and Egerod in excluding the Dasycladaceae from the Siphonocladales and putting them in a separate order, the Dasycladales. As Egerod points out, the Dascyladales differ from the Siphonocladales in possessing discoid plastids, a uninucleate vegetative thallus (where studied) and in many cases special reproductive cysts.

Feldmann and Egerod, however, differ in their concept of the Siphonocladales in that the former includes the Cladophoraceae, whereas the latter accepts the viewpoint of Fritsch (1947) and Boergesen (1948) that the Cladophoraceae should be placed in a separate order, the Cladophorales. The present author is of the opinion that Feldmann's viewpoint is the more correct. On this basis the Siphonocladales can be characterized broadly as an order in which all genera are septate at some stage of their existence, the cells or segments being multinucleate and possessing reticulate chloroplasts. Fritsch (1947) has suggested that the plastids of the Valoniaceae can be regarded as discs joined by delicate threads, and that in this respect they bear some resemblance to the Siphonales. On the other hand Nicolai and Preston (1952) have shown that the cell wall structure of *Valonia* is similar to that of species of *Cladophora*.

The Siphonocladales as presently understood by the writer include the following five families: Cladophoraceae, Anadyomenaceae, Boodleaceae, Siphonocladaceae and Valoniaceae.

The exclusion of the Cladophoraceae from the order by other writers is based upon their lack of the typical initial stage of development, namely the existence of an erect, tubular, primary vesicle. However, it is not difficult to envisage slight elaboration of the basal cell of species of *Chaetomorpha* (fig. 1), especially *C. darwinii*, to the condition found in *Microdictyon* and *Cladophoropsis* (fig. 2). Further development of the condition found in

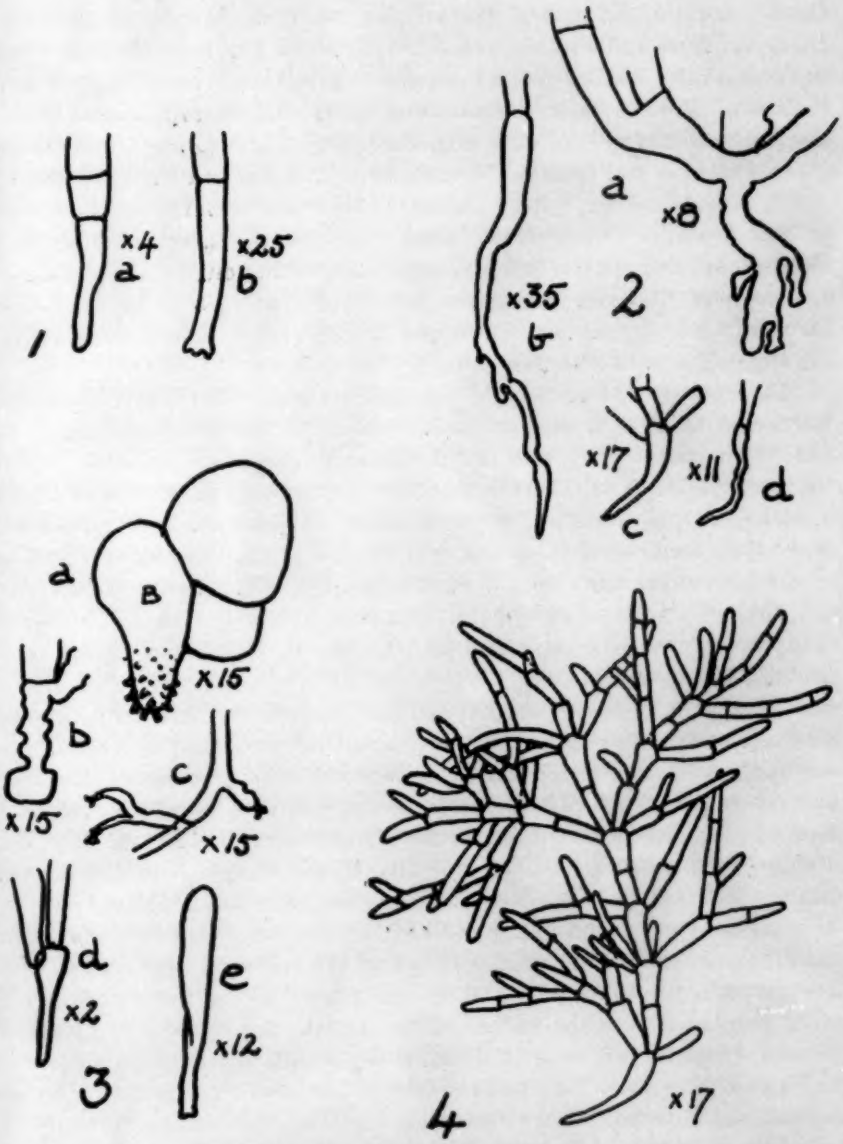


FIG. 1. Basal cells: a) *Chaetomorpha darwinii*. b) *C. aerea*. FIG. 2. Basal cells: a) *Cladophoropsis membranacea*. b) *Microdictyon japonicum*. c) *M. mutabile*, spongiose plant. d) *M. mutabile*, sporeling. (a, b, after Egerod; c, d, after Dellow). FIG. 3. Basal cells: a) *Dictyosphaeria favulosa*. b) *Siphonocladus tropicus*. c) *Boodlea siamensis*. d) *Valonia trabeculata*. e) *Siphonocladus tropicus*, young plant. (a–c, after Borgesen; d, e, after Egerod). FIG. 4. *Microdictyon mutabile*: Portion of spongiose thallus. (After Dellow.)

these genera would lead to the vesicles found in *Boodlea, Siphonocladus, Dictyosphaeria* and *Valonia* (fig. 3). Apart from this issue there is, however, the remarkable similarity between the *Cladophora* type of thallus and the thallus of *Microdictyon mutabile* and species of *Cladophoropsis*. There is also the similarity in wall structure between *Valonia, Siphonocladus, Dictyosphaeria* and species of *Cladophora* (Nicolai and Preston, 1952).

M. mutabile described by Dellow (1950) is a remarkable species found in New Zealand. Two distinct forms exist: one is markedly spongiose and the threads have relatively few anastomoses, so that on casual examination it can easily be mistaken for a coarse species of *Cladophora* (fig. 4). The other form, which under certain conditions develops from the spongiose form, has the typical habit of *Microdictyon*.

The genus, *Cladophoropsis,* has had a chequered history. Founded by Boergesen in 1905 it was originally placed in the Cladophoraceae. Later (1913) he transferred it to the Boodleaceae and more recently (1948) to the Siphonocladaceae. There is therefore justification for a close relationship to both Cladophoraceae and Siphonocladaceae. *Cladophoropsis membranacea* is the type member of the genus, but there are other species in which some of the lateral branches do not remain in open connection with the mother cell, thus resembling *Cladophora*. This is particularly true of *C. membranacea* var. *repens, C. herpestica* and *C. lyallii,* all species found in New Zealand (Chapman in press).

It would seem therefore that the justification for excluding the Cladophoraceae from the Siphonocladales cannot be completely sustained, and if one includes the Cladophoraceae within the Siphonocladales one has an orderly sequence of phylogenetic development. It is worth noting that Egerod (loc. cit.) admits that the Anadyomenaceae (which includes *Microdictyon*) represents a distinct difficulty if one accepts both Cladophorales and Siphonocladales. The above solution eliminates this problem.

Another issue raised by Egerod (loc. cit.) is concerned with the origin of the Siphonocladales. Her argument is that the ancestral type may have been a plant akin to *Protosiphon,* which she places in the Chlorococcales. Her main points refer to the nature of the vesicle and method of cleavage in *Protosiphon,* and it is suggested that it is not difficult to derive a plant such as *Valonia ventricosa* from a Protosiphon-like alga. If this viewpoint is accepted, one must also accept the view that the Valoniaceae form the most primitive family, and that the Siphonocladaceae and Anadyomenaceae are secondarily septate. It should be noted that recently Nicolai and Preston (1952) have hinted that the Protosiphoneae have an alliance with *Halicystis* (Siphonales) rather than *Valonia* in so far as wall structure is concerned.

The present writer considers that there are the following serious objections to Egerod's view and that it cannot be upheld:

1. The Chlorococcales, to which *Protosiphon* is assigned (including *Protosiphon* in this case) are practically all fresh water or terrestrial forms.

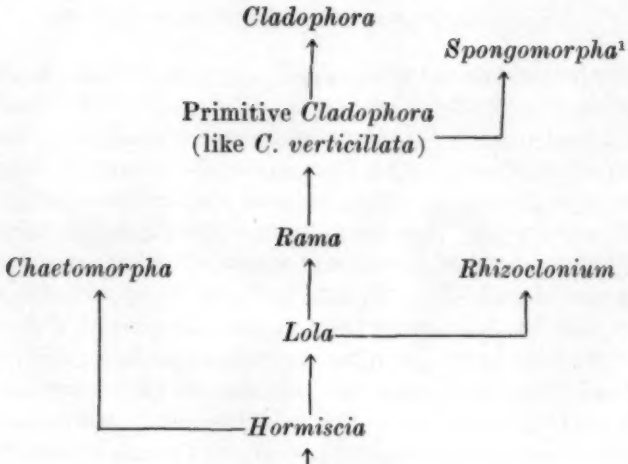
The Siphonocladales, on the other hand, are almost wholly marine, though there are some fresh water species in the Cladophoraceae. Whilst it may be argued that the primitive siphonocladaceous ancestor may have lived in relatively fresh or wholly fresh waters, and that over the course of years the descendants have gradually become more or less restricted to salt water, one could legitimately expect that some of the simpler members of the Siphonocladales would at least live in brackish waters. The Valoniaceae (the primitive family according to Egerod) are, however, strictly marine.

2. Work that has been carried out on the life cycle of *Valonia* (Schechner-Fries 1934, Schussnig 1938) has shown that the species investigated are wholly diploid, reduction division taking place at gametogenesis. This is the type of life cycle typically associated with the more advanced (Siphonales) rather than the more primitive members of the Chlorophyceae. *Protosiphon*, from which it is suggested the Valoniaceae may have been derived, almost certainly has a wholly haploid life cycle, reduction division taking place at zygote germination. It would be necessary to assume, therefore, that at some intervening period a whole series of forms must have arisen in which a diploid phase was introduced into the life cycle and the haploid phase subsequently lost. One could expect that one or more of such forms might well have survived.

3. Work that has been carried out on the life cycle of *Microdictyon* (Iyengar and Ramanathan 1940) and *Anadyomene* (Iyengar and Ramanathan 1941) has shown that there is a regular alternation of generations in the life cycle of species of these two genera. It is probable that most workers would consider the wholly haploid type of life cycle as being the most primitive, though recently Feldmann (1952) has argued that the life cycle with regular alternation of generations is the most primitive. Unless reduction or an abnormality can be clearly established, either of these two types of life cycle must be regarded as primitive to the wholly diploid type. There seems no reason for regarding *Microdictyon* or *Anadyomene* as reduced forms in the Siphonocladales, so that if the Valoniaceae are regarded as the primitive family it would imply that the Anadyomenaceae would have to be removed from the Siphonocladales.

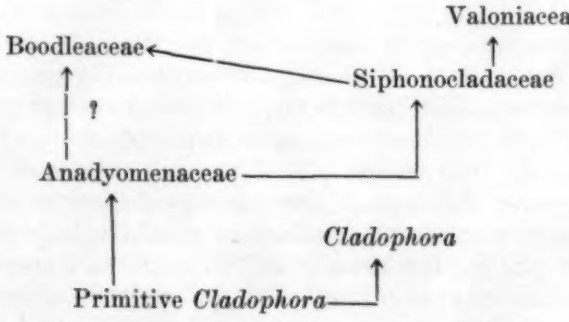
At this point an alternative interpretation of the situation in the Siphonocladales may be presented. In this alternative it is suggested that the primitive family is the Cladophoraceae and that the Valoniaceae represent the final stages in reduction and elimination of septae within the order.

On this basis we start with a family in which there is either a haploid generation only in the life cycle or else alternation of generations in the life cycle, with only one certain case of a wholly diploid life cycle (*Cladophora glomerata*). As a result of studies of the New Zealand marine Chlorophyceae (Chapman 1952 and in press), the present author has considered the course of development within the Cladophoraceae (Chapman 1953) and has proposed the schema below:

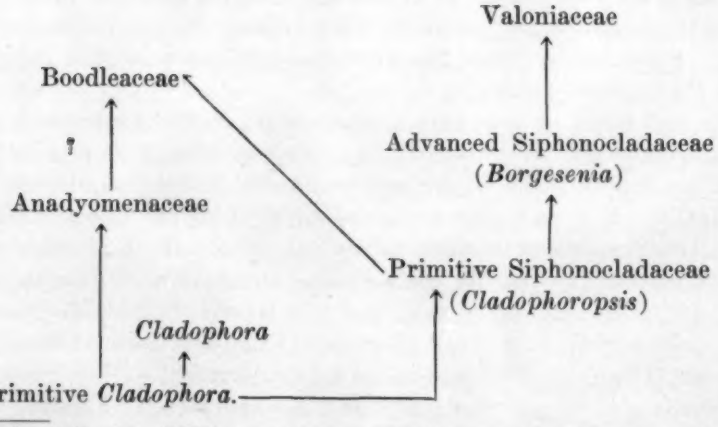


On this basis it would seem that one can build the remainder of the Siphonocladales according to one or other of the two schemas below:

A.



B.



[1] Nicolai and Preston (1952) present arguments for separating *Spongomorpha* completely from *Cladophora*.

Fritsch (1947) argues that the genus *Cladophora* represents the most advanced type in the Cladophoraceae and that any affinities with other families must lie in genera such as *Rhizoclonium, Lola* and *Chaetomorpha.* If this view is accepted, then it is indeed difficult to find forms bridging the gap between the Cladophoraceae and any of the other families of the Siphonocladales. The argument presented by me stresses the relationship between *Cladophora* and *Microdictyon* on the one hand and *Cladophora* and *Cladophoropsis* on the other: on this basis there would seem to be no justification for excluding the Cladophoraceae from the Siphonocladales.

The relationship of the Boodleaceae raises a problem, because on the one hand *Microdictyon* provides a link with the Anadyomenaceae and on the other hand *Cladophoropsis* provides a link with the Siphonocladaceae. However, acceptance of the first view would also involve acceptance of a dual origin of segregative cell division, which is apparently absent in the Anadyomenaceae. Whilst there is no reason why this type of cell division should not have arisen on more than one occasion, it would seem more likely that such a special mode of cell division only arose once. Under these circumstances the origin of the Boodleaceae from the Siphonocladaceae would seem the more probable. The other and less likely alternative is therefore represented in the schemas by a dotted line.

Of the two schemas put forward the present author favours B, because the net type of thallus (Anadyomenaceae) is in most cases well developed, and would seem to represent an end line in evolution as indicated in scheme B. In either scheme *Microdictyon mutabile* is regarded as possibly the most primitive member of the Anadyomenaceae, and in scheme A would be the point from which the Siphonocladaceae would have to be derived.

In conclusion the present author believes that Scheme B, superimposed on the schema for the Cladophoraceae (Chapman 1953), represents most satisfactorily, in our existing state of knowledge, the relationships and status of the Siphonocladales.

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ALPINE FIR AT TAKU GLACIER, ALASKA WITH NOTES ON ITS POSTGLACIAL MIGRATION TO THE TERRITORY[1]

C. J. HEUSSER

Alpine fir (*Abies lasiocarpa* (Hook.) Nutt.) was found during the summer of 1952 growing on the northern end of the east ridge bordering Taku Glacier (fig. 1). The exact location is at Camp 11A on a map of the Juneau Ice Field already published (Lawrence 1950). This station on the southeast flank of the ice field, 25 miles northeast of Juneau, is new for the species in Alaska.

Fir occurs at two sites on southwest-facing, granodiorite spurs at about 3,300 feet elevation, nine miles above the terminus of the glacier. Both sites are characterized by isolated clumps of krummholz trees in the alpine heath at timberline. They consist of mountain hemlock (*Tsuga mertensiana* (Bong.) Carr.) with only a few specimens of fir. Shrubs and herbs growing under the trees include five-leaved bramble (*Rubus pedatus* J. E. Smith), blueberries (*Vaccinium caespitosum* Michx. and *V. uliginosum* L.), and bunchberry (*Cornus canadensis* L.).

The largest fir is as much as five feet in height and approximately four inches in diameter, growing erect with a sturdy leader from a decumbent bole. No staminate nor carpellate cones were seen, although mountain hemlock was in anthesis at the time (9 July). Later in the season, Arthur Gilkey, leader of the 1952 party, photographed a small upright branch bearing a mature cone. Reproduction is largely vegetative by means of layering. This type of propagation has been described as common for alpine fir at timberline (Cooper 1911, Oosting and Reed 1952).

The tree has been reported from stations elsewhere in southeastern Alaska (Sudworth 1908, Anderson 1919, Taylor 1929). Specimens are noted from the vicinity of Chilkoot and White Passes, extending from sea level at the head of Lynn Canal near Skagway to timberline at 3,000 feet. This area is 75 miles to the north-northwest of the Taku Glacier station. The species is also found 250–275 miles to the southeast on Very Inlet, at the head of Portland Canal, and along Boca de Quadra. Anderson (1918) states that "what appears to be" silver fir (*Abies amabilis* (Dougl.) Forbes) occurs along Taku River, three miles above the mouth at Taku Inlet. Hultén (1941) is, however, of the opinion that this might more likely be alpine fir.

[1] Contribution from the Juneau Ice Field Research Project which is directed by the American Geographical Society through contract with the Office of Naval Research. Acknowledgment for assistance is accorded the members of the 1952 party, the Air Force Tenth Rescue Group, and the U. S. Forest Service. The manuscript was prepared in the Osborn Botanical Laboratory at Yale University with the aid of the Theresa Seessel Fellowship.

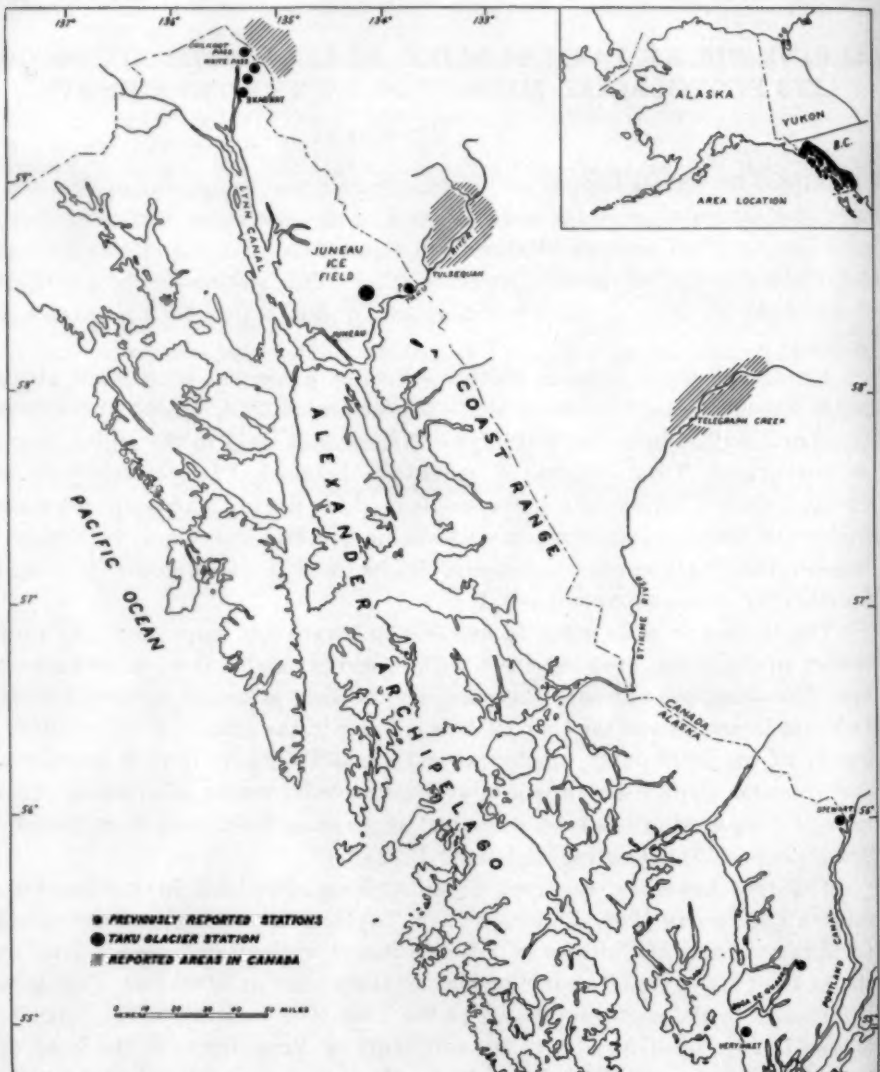

FIG. 1. Sketch map of southeastern Alaska and adjacent Canada showing location of alpine fir at the Taku Glacier station and at other Alaskan stations and areas in British Columbia. Region is shown in black on inset map.

Silver fir in the Territory has only been determined in the region of the southeast boundary at Portland Canal. These localities constitute the only ones on the west slope of the Coast Range in Alaska prior to finding the tree at Taku Glacier.

Alpine fir is more commonly reported from the east slope of the Coast Range in British Columbia. Kerr (1948a, 1948b) writes that it occurs in the Stikine and Taku River Valleys, and Halliday and Brown (1943) indicate a high percentage in the Babine-Stikine region. Sudworth (1908) has presented a comprehensive list of stations including White Pass and the mountains about Telegraph Creek.

The distribution of alpine fir in Alaska reflects climatic conditions of the interior east of the Coast Range. The occurrence of this species at Portland Canal, in Taku Valley, and at Skagway is coincident with relatively dry areas exhibiting more of a continental than a maritime climate. The Alaskan "panhandle" is notably moist, and precipitation generally ranges between 80 and 150 inches annually (Kincer 1941). The heads of inland waterways and valleys in the heart of the Coast Range where alpine fir is found are, on the other hand, comparatively dry. Stewart, British Columbia, at the head of Portland Canal, averages 66 inches annually (Province of B. C. Dep. Agr., 1951). Tulsequah, British Columbia, in the Taku Valley, recorded 27 inches in 1950. Skagway, at upper Lynn Canal, reports an average of 26 inches. Climate east of the Coast Range is drier. Telegraph Creek, on the Stikine River, averages about 8 inches (Connor 1938). Precipitation at the Taku Glacier station reported in this paper is between 107 inches at Annex Creek, 15 miles south, and 27 inches at Tulsequah, 20 miles east. It is probably most comparable with that at Stewart.

Alpine fir presumably spread to the Territory from an unglaciated refugium (or refugia) in western Yukon Territory and/or an ice-free corridor in western Alberta that existed between the maxima of Keewatin and Cordilleran glaciers (Hansen 1949, 1950). This thesis supports the view of Hultén (1937) that continental Western America-radiants of boreal biota including alpine fir survived the last glaciation in such areas.

During early postglacial time, dwindling ice of the Cordilleran glacier complex filled the valleys transecting the Coast Range. It was not until middle postglacial time that those between the coast and the interior were ice-free. This latter interval was warmer and drier (Heusser 1952), and under such conditions, alpine fir was able to ecize westward through British Columbia as suitable terrain became deglaciated. Timberline was higher during this interim, and forest trees were able to migrate into Alaska over low passes and through river valleys, such as White Pass and Taku Valley. The presence of isolated individuals of Sitka spruce (*Picea sitchensis* (Bong.) Carr.) under a cooler climate at almost 4,000 feet on nunataks in the Juneau Ice Field, eight miles from timberline, would favor this consideration. With increasingly adverse conditions imposed by the late postglacial ice maximum or "little ice age" (Matthes 1939), the migration of

fir became impeded. Such communities as those at upper Taku Glacier have survived the rigor of late postglacial climate.

DEPARTMENT OF EXPLORATION AND FIELD RESEARCH,
AMERICAN GEOGRAPHICAL SOCIETY
NEW YORK, N. Y.

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TORREYA

WHY I LIKE TAXONOMY—SEVEN MEDITATIONS[1]

ROBERT E. WOODSON, JR.

I wonder how many of you saw the big full-page advertisement at the back of the comic section of the 'Phi Beta Kappa Key' one Sunday a few weeks ago? I didn't see it myself because, although you may not have guessed, I am not one of the bretheren. But a friend of mine who is a Phi Bet noticed it and thought I might be interested. It read, and I quote (my friend, that is):

COME ONE COME ALL

WIN A BIG CASH PRIZE

[exclamation mark]

JOIN OUR COLOSSAL NATIONWIDE CONTEST

ALL YOU HAVE TO DO to win one of these BIG CASH PRIZES is to tell us in 500 words or less WHY YOU LIKE TAXONOMY. IT'S A CINCH because EVERYBODY LIKES TAXONOMY [exclamation mark]. Each and every contestant is entitled to write as many letters as he or she likes telling us why HE (or SHE) LIKES TAXONOMY, but no entries will be returned to the contestant and all will be considered the property of

KRISPY-KRUNCHY PLANT PRESSES, INC.
Cambridge 38, Mass.
[of all places]

HURRY HURRY HURRY

(Contest closes midnight, September 8, 1953)

It may safely be presumed, I presume, that at this gathering all of us present like taxonomy, as the advertisement says. And since at least enough of you, ladies and gentlemen, are my friends to have voted me into my present unenviable position, I am going to take you into my confidence and read you my answers before I rush them Special Delivery to beat the deadline. Don't look now, but I'm submitting seven entries: Seven—count 'em—seven!

I

I like taxonomy because—well—frankly, because I like flowers. I apparently don't have the passionate feeling that we see in some men and women. But I hope that I shall always remember how the blue columbine was spangled with spring raindrops in my grandmother's garden, and how the white plantain lilies looked and smelled in the corner of her stone chimney. Aside from their beauty of form and color, there is a healthful, peaceful detachment in flowers that (to be cautious about it) must be imparted much less freely by white mice and fruit flies. Perhaps I just don't understand, but I feel that one of the rewards of plant taxonomy is simply the flowers themselves.

Even herbarium specimens, some of them, make one catch his breath for their beauty. Because, as one of my graduate students once told me in a brief moment of revelation, when you know them well they aren't flat anymore.

Nearly everyone loves flowers. Why, then, in spite of all the popular men's garden clubs and the like, do we sometimes wish that we were zoologists when another man asks us our business? Do you, as I, sometimes try to evade by saying that you are a biologist, hoping that the other will infer a lie? Why should we feel guilty about our association with plants? Are plants, by their nature, irrelevant and trivial?

[1] Address of the Retiring President of the American Society of Plant Taxonomists. Read before the Annual Meeting, September 8, 1953, Madison, Wisconsin.

I wonder how the flowers feel about it. Are they ashamed to call themselves plants because of their association with botanists—particularly plant taxonomists? I think that sometimes they might.

II

To be quite candid, Taxonomy was not my first love. Her name was Geography. But that was puppy love. You see, I was in third grade. I can't look back upon Grade School with any great pleasure except for the moments—yes, the hours—that I spent with Geography: those vast, beautifully colored maps, the inset sketches and photographs that could transform a thin, crooked line into a mysterious river, and tiny circles and dots into cities and towns so different from my own.

So Freud would understand why I like taxonomy because I like the sound of faraway places. I have not travelled very widely for this day and age; most of my students have seen more than I, thanks to the wars. But I am able to tell them still more, and not stir out of the herbarium.

The corner stone of our herbarium at the Missouri Botanical Garden is the herbarium of Bernhardi, once professor at the University of Erfurt. When it arrived in St. Louis in 1858 it was found to contain amongst its treasures many specimens bearing only such notations as "Unalaschka" or "Sitka," and occasionally a name by Schlechtendal and Chamisso. A little detective work has proved that this collection, indeed, is that made by Chamisso in Alaska in 1816.

Adelbert von Chamisso was the foremost German lyric poet of his day. But he, also, loved flowers and the sound of faraway places. In 1815 he sailed with Captain Kotzebue from St. Petersburg aboard the tiny brig "Rurisevk," 27 hands aboard. Out the Neva and south around the Cape and up the China Coast and at last the fires of Alaska on the beam. Upon that foggy icy shore the poet found these flowers, and brought them back to Russia and to us.

Here is the type of *Asclepias arenaria*. It was preserved for us by Frederick Wislizenus, M.D., esteemed member of his profession in the bustling frontier town of St. Louis on the Mississippi. The place was the sand dunes south of Santa Fe, and the time was August, 1846. A band of Gringo scouts came upon him there and swore he was a mirage. One morning, good Dr. Wislizenus had set out from his office on Chestnut Street, alone in his sedate black buggy, and drove and drove on this incredible ride into the midst of the Mexican War, until we find him here.

These ugly thistles were bought with bombs and death beside Lake Tana, the Blue Nile's headwaters. Ethiopia, in 1937! Years afterward my friend sent them to me; my friend who gathered them, a gentlemen and a gentle man.

Here are three mementos of a Yorkshire boy who ran away to sea. James Cook was his name: Captain Cook to *you*, sir. He sailed well and he fared well, and in 1768 was chosen master of H.M.S. "Endeavour" to sail 'round the world with Sir Joseph Banks and his botanist, Solander. In 1770 they sighted legendary *Terra Australis* and claimed it for His Brittanic Majestry, George III. There every plant was strange, and Botany Bay it still is. This blackened, brittle shrub then bloomed on that wild shore; it is here to speak of Cook, and Banks, and an empire upon which the sun would never set.

This sprig of *Nothofagus* once rustled in the dwarf forests of Tierra del Fuego, where it was plucked by the brothers Forster, lucky to be with Commander Cook on his second voyage of discovery, in 1773. No continents were Cook's this trip, but the magic of fruits and fresh green herbs.

And this common weed of many shores of many lands. In 1779 it was gathered by young David Nelson upon the sunny beach where tomorrow the great navigator would be struck down in ambush. (And ten years more, Nelson with Captain Bligh adrift in mid-Pacific.)

III

I like taxonomy because I like puzzles. Besides the problems peculiar to itself, biology compounds all the problems of all the other natural sciences,—plus mathematics. (Always mathematics!) Taxonomy is the apex of this staggering (and enticing) pyramid of question marks. Beneath it are the stones of geography and geology and meteorology;

and beneath them the stones of morphology and anatomy and cytology and gentics; and beneath them the stones of physiology and biochemistry. . . . And Goodness knows what else, for the ologies are increasing every day and I, for one, cannot keep up with them. Doubtless within the crypt of the pyramid is enshrined the nucleus of the sacred atom. But the name of the pyramid is "Organic Evolution," and the symbolism of taxonomy is, or should be, the capstone.

In an herbarium we find so many discordant annotations upon the sheets, so many erasures, so many corrections. In the taxonomic library so much synonymy, so much criticism (magnanimous and otherwise). Once, in an idle moment, it struck me that one of the palaces of the New Jerusalem should be a celestial herbarium, each sheet with but one and truly authentic annotation. A duplicate set should be housed in Hades, but these, besides the *determinato Divinitatis*, bearing full synonymy; yours and mine, our forebears', and of our seed from now till Doomsday. What could be more damning? But on the other hand, would Heaven be Heaven with all the puzzles solved? Purgatory may adapt us to it.

IV

We need species for much the reason that we need inches and centimeters and all the rest, we tell our laymen (trying, I suspect, to strike a scientific sounding phrase and so impress them). I say that evolution is like music that we learn by ear and painfully transcribe. Everchanging moods and tempo, sharps and flats and signatures; "thundering crescendos," "hushed diminuendos," "rests that speak more eloquent than sound." We, poor mortals, set ourselves to score the magic anthem (some tone-deaf or lacking rhythm).

Our taxa are the measures, phrases, movements—each with its own contribution to the whole. Is it strange that the same bar should be transcribed so differently by you and me?

Taxonomy is re-creative; it is intuitive; it is an art and not a craft. It is not describing; it is not identifying. Those are just pieces—and not all. Taxonomy is the whole. And that is why I like taxonomy, because I am an artisan at heart.

V

I like taxonomy because I like the taxonomists. We have a lot in common. Maybe they are a bit queer, but on the whole they (I mean we) are a grand crowd. Of course there is a sprinkling of Dr. Fells amongst us (the reason why, I cannot tell); and as for the really black sheep of the family (and their friends), I can only kow-tow in the general direction of the late W. S. Gilbert and burst into anguished song:

As some day it may happen that a victim must be found,
I've got a little list—I've got a little list
Of taxonomy offenders who might well be underground,
And who never would be missed—who never would be missed!
There's the pestilential nuisances who write for separates—
Curators who take kleptotypes and split duplicates—
Authors of two-page "monographs," and nomenclature cranks—
Those who write for "county records," merely adding "Many thanks"—
Curators who on returned loans in stamped sequence insist—
They'd none of 'em be missed—they'd none of 'em be missed!

There's the boy scouts who are working on their merit badge, they say,
And the plant pathologist—I've got *him* on the list
And the folks who ask for lectures and never think to pay,
They never would be missed—they never would be missed!
There's the man who names each color form as soon as it is found,
And who changes varieties to subspecies or the other way around;
And the guy who loves to tell how many species bear his name,
But whose pencilled annotations are his clearest bid for fame;
And that ultra-modern genius, the biosystematist—
I don't think he'd be missed—not by *me* would he be missed!

And that legalistic schemer, who just now is rather rife,
The plant morphologist—I've got *him* on the list!
All know-it-alls, kibitzers, and clowns of public life—
They'd none of 'em be missed—they'd none of 'em be missed!
And ambitious physiologists of an *enterprising* kind,
Such as—Whatchmacallum, Yehudi, and likewise Nevermind,
And Wahoozis, and Whatsisname, and also Unowho—
The task of filling in the blanks I'd rather leave to *you*.
But it really doesn't matter whom you put upon the list,
For they'd none of 'em be missed, they'd none of 'em be missed!

VI

There are few things more exhilarating and comforting than telling something old to someone new. Particularly if that one is the younger. I like taxonomy because it has led me into teaching.

When I first began to teach, my classes were my younger brothers and sisters: each year fresh dozens of them; droves of them, so few without one trait I could admire. Fall was the most exciting time of year, with the new ones flocking in, and some old ones flatteringly "just looking in to see what's going on." I lectured them and evanglized those that I thought would make good evangelists; and they taught me, too. Agility and patience are required by students not quite decided if they wish to learn.

And the field trips! I wish I knew how many brides have told me: "Charlie says to ask how you make coffee." (Or Sam, Russ, Bob, Dick, or Henry.) Well—you fill a smudgey pot to not-quite-full from the spring at the foot of the hill. Pull out a few dead leaves and wrigglers. (While you're there, snatch a handful of cress.) In stumbling up the slope, be sure to lose about half to three-fifths of the water. And if the fire is burning brightly, now get the coffee half spilled in the pack. Count noses round the fire—two spoons for each; when the water is hot, throw it in. Then have a jolly time and sing your songs till the pot bubbles over. And, Oh— at last do not forget to stir the fire; the ashes will settle the grounds.

I miss them, now that I have grown old enough and wise enough (the University considers) to be confined to Graduate School. I have disciples now, and must remember that I am a son of Greenman, who was a son of Engler, who was a son of Goeppert, who was a son of Beckmann, who was a son of Linnaeus.

VII

I was about to write "I like taxonomy because it is my livelihood," but it would be more true to say "I like my livelihood because it is taxonomy."

When students ask me "What opportunities are there in plant taxonomy?" I tell them: if you would rather study plants than anything, you will be successful; if there is anything you'd as lief be doing, you will be a failure. Adopt no other measure. I would say that happiness is success, and unhappiness is failure.

Look at me: I am as happy in my work, I think, as any man. But then look at my salary cheques; I would be poorly paid (working on holidays and Sundays as I do) if I were a plasterer, a carpenter, a steam fitter, a drill press or bulldozer operator. . . . How can I say I like taxonomy because it is my livelihood?

Look at my boyhood friends: stockbroker, bag manufacturer, tobacco processor, packinghouse executive, lawyer. . . . If they were paid as I, would they still call their lives successful? If I were paid as they, and they as I, would not there be more plant taxonomists? What would they do, then, with their Saturdays and Sundays and all their holidays, and their mornings before ten and their evenings after four which they use, now, to flee the work that pays them so well?

I cannot say that I am underpaid. What I am paid is paid to live with beauty, adventure, day dreams, fascinating puzzles, beautiful and profound designs, and companionship. These are other men's relaxations. The things they hope to do when they retire. I am paid for this; doing the things and talking about the things I would rather do and talk about, year by year—each with a fresh group of friends.—Missouri Botanic Garden.

Field Trip Reports

July 26. Allaire State Park, Allaire, N. J. The historic significance of this interesting park was explained. In a nearby field there were found *Lilium superbum*, *Lycopodium alopecuroides*, and *Drosera intermedia*. Along a roadway nearby was a stand of *Habenaria blephariglottis* and a few plants of *Habenaria ciliaris*. The ripe blueberries and Phoenician wineberries were enjoyed for dessert. Attendance 7. Leader, Vernon L. Frazee.

Aug. 8–9. Pine Barren Weekend. Two areas were visited at Oceanville, N. J., one of them yielding *Xyris congdoni*, *X. torta*, *X. caroliniana*, *Gratiola aurea* and *Fuirena squarrosa*. The second contained Venus flytraps (transplated several years ago from North Carolina), which have been flowering yearly and setting seed. Native vegetation in this bog included *Sabattia lanceolata* and *Schizaea pusilla* with their expected associates.

Calopogon pulchellus was still in bloom at Cologne, rather late for the species. A gratifying list of bog plants were found blooming normally. *Rhexia virginica* was present here but the station for *R. mariana* near *Harrisville* had bowed to the scythe. *Lobelia canbyi* was located in a nearby savanna. The *Lobelia cardinalis* station at Green Bank was found to be decreasing while *Smilax walteri* was holding its own.

Sunday, after a look-around at Atsion, the group visited the *Lygodium palmatum* stand at Hampton Furnace on the way to botanically historical Quaker Bridge. Here a bog containing *Habenaria integra* was visited. This is conceivably the old station for the species mentioned in Britton's Catalogue (1889), but which Witmer Stone and his contemporaries failed to find. It was relocated in 1952 by Hirst and Leisy. Associates included: *Juncus caesariensis*, *Xyris fimbriata*, *Abama* (in fruit), and *Sclerolepis uniflora*. Nearby, Anderson's tree-frog (Hyla andersonii) was captured for all to see and then released. At the Bridge proper five species of Smilax were recorded (*S. rotundifolia*, *S. glauca*, *S. laurifolia*, *S. walteri*, and *S. herbacea*). The leaders feel that the borders of the Atsion and Batsto rivers will yield more rarities. A club trip will be conducted there in mid-July 1954. Attendance 18. Leaders, David Fables, Frank Hirst, and Cy Leisy.

Aug. 16. Marksboro, N. J. The trip to the white marl pond in the vicinity of Squires Corner proved to be one of the most productive and interesting of the Club's field expeditions this year. Britton's Catalogue (1889) mentions many limestone species present at White Pond in 1884, according to Porter. Every species mentioned in the Catalogue that might be expected to be in flower at this season was observed by the group. Among the limestone species noted were the following: *Cystopteris bulbifera*, *Pellaea atropurpurea*, *Asplenium ebenoides*, *A. ruta-muraria*, *Carex flava*, *C. cryptolepis*, *Rhyncospora capillacea*, *Salix candida*, *S. serissima*, *Waldsteinia fragarioides*, and *Lobelia kalmii*. Other species included *Phlox subulata*, *Sarracenia purpurea*, *Xanthoxylum americanum*, *Ipomaea pandurata*, and *Potentilla fruticosa*. A species of *Eleocharis* rooting after the manner of *E. rostellata* but too far past the fruiting stage to identify awaits recognition on a trip which is planned for next season. Attendance 8. Leaders, G. G. Nearing and L. E. Hand. Reported by David Fables.

Aug. 30. Great Kills Marine Park, Staten Island, N. Y. Though shore birds were not abundant, there were some of them in a brackish pond near the causeway. Several great blue herons flew out, along with black ducks, black-crowned night herons and green herons. Many peeps and semi-palmated plovers fed in puddles near the shore, but the prize of the day was a Wilson's phalarope which played around in this pond for hours; it was still there when we came back 4 hours later. Also observed here were several sora rails and a western sandpiper. Ruddy turnstones, sanderlings, a piping plover and black-bellied plovers were seen along the beach. Attendance 17. Leader, Mathilde P. Weingartner.

Sept. 20. Pluckemin, N. J. Flood plain sites along the north branch of the Raritan River were visited. A woods near the river, but above the normal flood level, had an unusual forest floor cover of sugar maple seedlings. Sugar maple was the numerically dominant mature species. However, red oak, white ash, and others were larger.

The largest trees were seen on the flood plain near the river: *Fraxinus americana*, 38

inches in diameter; *Fagus grandifolia*, 33 ins.; *Quercus alba*, 29.5 ins.; *Liriodendron tulipifera*, 28 ins.; *Tilia americana*, 22.8 ins. The most obvious flowering plants were *Solidago latifolia* and *Aster divaricatus*.

The river was low and we were able to wade across it to a small island. The island was rich in herbaceous growth and supported large sycamore, shagbark hickory, black walnut and butternut trees. The stream at the other side of the island was almost dry enabling the group to investigate a red shale bluff upon which grew a small stand of hemlock. Growing near the base of the bluff the walking fern, *Camptosorus rhizophyllus*, and the ebony spleenwort, *Asplenium platyneuron*, were quite common. Large blooms of algae were found in the slack waters of the river. Attendance 6. Leader, Warren A. Wistendahl.

Oct. 3. Middlesex Co., N. J. No customers applied.

Oct. 4. Staten Island, N. Y. In spite of prolonged dry weather enough grasses were in good condition to enable the group to identify about 50 species. Several spring flowering grasses which had dropped seed early in the season were found in full bloom, e.g., orchard grass (*Dactylis glomerata*) and quack grass (*Agropyron repens*). Interesting species of grasses found on or close to the seashore included two species of *Cenchrus*, *C. pauciflorus* and *C. tribuloides* (sand burr), *Ammophila breviligulata* (Marram grass or beach grass), *Triplasis purpurea* (purple sandgrass), *Panicum amarum*, *Aristida tuberculosa*, *Eragrostis spectabilis* (purple love grass), *Tripsacum dactyloides* (gama grass), *Andropogon scoparius*, and *Sorghastrum nutans* (Indian grass).

New locations were discovered for several grasses on Staten Island in addition to one species, *Panicum miliaceum* L., which has not been reported from this area for many years. A last surviving stand of *Clematis ochroleuca* Ait., containing about three seed-bearing specimens, was found. Efforts will be made by the leader and Mr. Dave Fables to propagate the species in more promising areas. Attendance 4. Leader, Robert C. Meyer.

Oct. 10–11. Sussex County weekend. The prolonged drought had considerable effect upon some of the herbaceous plants. Many species were unobserved that should have been present. Some of those observed were markedly stunted. *Gentiana crinita*, *Salix serissima* (in fruit), and *S. bebbiana* were seen at Andover Junction. At Springdale late blooms of *Adlumia fungosa* festooned some of the low shrubs in walking fern terrain. Opposite this station the leader relocated *Boltonia asteroides* at perhaps its only location in northern New Jersey.

Mashipacong Pine Swamp was visited on Sunday to see false mistletoe (*Arceuthobium pusillum*) on the black spruces. How many actually parasitic seed plants do we have in the Torrey range? *Myrica gale* and *Eriocaulon septangulare* were observed at Lake Marcia. The general foliage was colorful but slightly sub-standard because the drought had caused many trees to drop their leaves ahead of time. Attendance, 14. Leader L. E. Hand.

BOOK REVIEWS

Allgemeine Pflanzenkaryologie. von Professor Dr. Georg Tischler. 2. Hälfte: Kernteilung und Kernverschmelzung. Drei Liferungen. Berlin-Nikulassee: Naturwissenschaftlicher Verlag, 1951.

It is a well-known fact that German scientists are masters in compiling encyclopaedic works in different branches of science. Some of the German handbooks are so detailed that nothing of value has been left out, and they are written in a language so exact that nothing can be misunderstood. Maybe the reading of such books will become difficult and dry, as there is usually nothing to distract from the main matter page after page, but if the books are to be used mainly as manuals such a conciseness is essential.

Thirty years ago Professor Dr. Georg Tischler, the nestor of cytotaxonomy and one of the most outstanding contributors to cytology through half a century, published a huge volume in the German Handbuch der Pflanzenanatomie. His volume was, of course, devoted to plant cytology, or perhaps more correctly, plant karyology, and in this volume

Dr. Tischler presented the facts gathered up to that time in his field, which already was recognized as one of the most valuable branches of studies on evolution. The volume was dedicated to descriptive cytology rather than to speculations on the hypothetical or theoretical significance of the facts observed or measured. From the very beginning this manual was regarded as one of the most valuable contributions published in the Handbuch der Pflanzenanatomie, and it was sold out in a short time.

All biological sciences have grown tremendously since Dr. Tischler's Karyologie was first published, but probably none of them as much as plant cytology. This growth can be most easily demonstrated by a comparison of the first and second editions of this work. In 1922 only 1862 papers were referred to, while the second edition includes 8767 references—although it does not include references to papers published during the last ten years or all the many publications in applied cytology. It is also remarkable to observe that during the time since the first edition was published there has been a big change in the language used by the cytologists. In 1922 German was used more than any other language in cytological publications, while at present the great majority of papers are written in English.

A detailed description of this accurate work is not possible, and even the list of contents does not show all its values and variations. The cytologist interested in exact investigations on the influences of outer and inner factors on the cell divisions will here find references to all the valuable papers on these topics from the beginning of cytology up to the last world war. All the many specialists on mitotic divisions in all groups of plants can read about results, which are not available in most libraries, while the cytogeneticists studying meiosis from different angles will find a goldmine of references to facts on their subjects. By aid of good indices it is easy to find each subject in all the places where it is referred to, and the very comprehensive literature list gives the names and places of publication of all the thousands of papers Dr. Tischler reviews throughout the book.

Certainly, specialists looking on this monumental manual from different angles will not agree upon many its details, and several cytologists will without doubt regret that it does not include references to all the many available speculations and theories which try to see the data observed in the light of evolution and life processes. Some readers will, perhaps, also agree with one old botanist who said to Dr. Tischler already prior to the first world war when speaking about cytology, that it should be regarded as a "fashion of yesterday." However, still many more will agree with Dr. Tischler's answer at that time: "or of to-morrow," as cytology does not show any signs of senescence, and the needs for all the younger generations to get proper and impartial information about the cytological findings of the past cannot be properly filled by any other book hitherto published. Tischler's Karyologie is a book for every University Library and for every botanical and genetical institution where cytological works are being conducted. Speculative manuals are without doubt very useful and necessary for the student when learning to think within the branch of science he is mainly intrested in, but as a reference manual the Karyologie is more invaluable than all such speculative textbooks together.—ASKELL LÖVE, Department of Botany, University of Manitoba, Winnipeg, Canada.

Farwelliana: an account of the life and botanical work of Oliver Aktins Farwell, 1867–1944. By Rogers McVaugh, Stanley A. Cain, and Dale J. Hagenah. 101 (plus 8) pages and 7 unnumbered plates. Cranbrook Institute of Science, Bloomfield Hills, Mich. 1953. $0.75.

This account, Bulletin No. 34 of Cranbrook Institute of Science, is announced as a biography. The strictly biographical portion, however, requires only three pages. Farwell, being a bachelor, devoted himself to botany as he saw it and so the next eight pages are in a sense biographical. The authors explain his contribution to botany, that is, to taxonomy and local flora. There is some discussion of Farwell's philosophy of nomenclature which is in part expressed and in part deduced it appears. It is hard to say if the section on "Validity of Farwell's Names" is an explanation of his philosophy or the result of

it. His assignment of types and collection numbers was found to be equally confusing. As a result of this the authors have found it necessary to devote 71 pages to an "Annotated List of New Taxa Published by Farwell" which runs to "approximately 330 genera, species, and subspecific taxa." Nor is this all, there were new combinations, and there are nearly five pages, with a little or no annotation, devoted to a "List of New Plant Names Proposed by Farwell but Hitherto Not Listed in the Standard Bibliographic Indexes." It would seem that these 75 taxa must now be added to the chaos that these Indexes try to systematize. Needless to say that Farwell built up an impressive bibliography in the course of his botanical contributions.

Eccentric, heretic, or scholar, Farwell remains an outstanding example of diligent enthusiast for local flora. His productive career was almost completely limited to five Michigan counties around Detroit and the Keweenaw Peninsula. His collecting and study was in part "extra curricular" to his employment by Parke, Davis & Co. The herbarium built up there was presented to the University of Michigan in 1933 and his private collection is at Cranbrook Institute of Science. It appears fortunate that so large a proportion of his sheets are closely assembled. Farwell may also be credited with giving three botanists a good workout. It is hard to imagine how the authors could have done a better job. This reviewer found Farwell interesting where a taxonomist might have found him exasperating. In any event, students of Farwell, his plants, or his local area, will find this book helpful if not altogether comforting.—JOHN A. SMALL.

NOTE

The New York Times for Sept. 25, 1953 reported the death of Miss Nellie L. Condon, one of our regular field trip leaders for many years. Though interested in plants and general nature, Miss Condon's greatest enthusiasm was for snakes. We have made many trips with her to High Hill Beach, Long Island, and to Watchung Reservation in New Jersey as guests of the Reptile Study Society of America. J.A.S.

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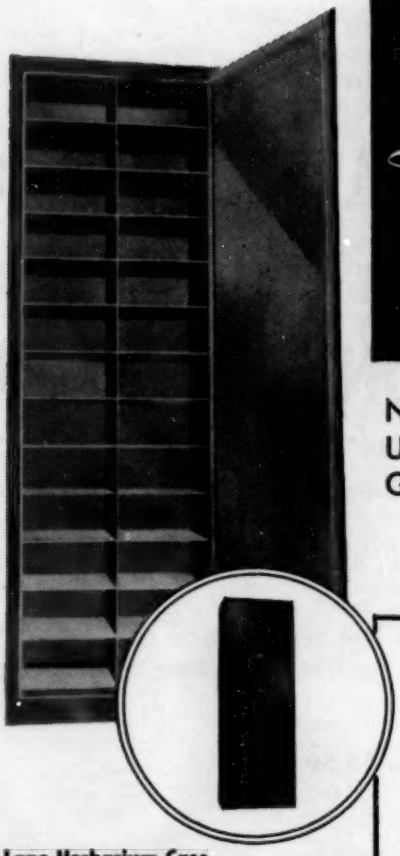

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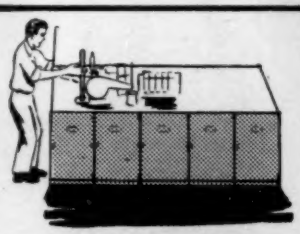

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